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The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

The *Proceedings*, begun in 1878, is intended primarily as a medium for the publication of original papers, based on the collections of the National Museum, that set forth newly acquired facts in biology, anthropology, and geology, with descriptions of new forms and revisions of limited groups. Copies of each paper, in pamphlet form, are distributed as published to libraries and scientific organizations and to specialists and others interested in the different subjects. The dates at which these separate papers are published are recorded in the table of contents of each of the volumes.

The present volume is the seventy-third of this series.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogues of type-specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

ALEXANDER WETMORE,
Assistant Secretary, Smithsonian Institution.

WASHINGTON, D. C., *July 3, 1929.*

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By Edwin Linton

Of the Zoological Laboratory, University of Pennsylvania

With two exceptions the hosts from which the trematodes described in this paper were obtained belong to the Woods Hole, Mass., region.

Unless otherwise designated, all material obtained in the months of September to June, inclusive, was collected by the late Vinal N. Edwards. Notes on living material, as well as notes resulting from a preliminary examination of formalin material, were made in the course of successive summers at the laboratory of the United States Bureau of Fisheries, Woods Hole, Mass.

List of trematodes referred to in these notes with their hosts.

Parasite	Host
Haematotrephus fodiens, new species	*Gavia immer.*
Psilostomum lineatum, new species	*Larus argentatus.*
Psilostomum plicitum, new species	*Larus argentatus.*
Psilostomum varium, new species	*Gavia immer.*
Petasiger nitidus, new species	*Colymbus auritus.*
Himasthla elongata (Mehlis)	*Larus argentatus.*
	delawarensis.
	marinus.
	philadelphia.
	Nycticorax nycticorax naevius.
Himasthla incisa, new species	*Oidemia deglandi.*
Mesorchis pseudoechinatus (Olsson)	*Larus argentatus.*
	atricilla.
	delawarensis.
	marinus.
	philadelphia.
	Colymbus holbölli.
	Gavia immer.
Aporchis rugosus, new species	*Sterna paradisea.*
Stephanochasmus sp	*Ceryle alcyon.*
Cryptocotyle lingua (Creplin)	*Butorides virescens.*
	Gavia immer.
	Larus argentatus.
	atricilla.
	delawarensis.

Parasite	Host
Ascocotyle plana, new species	*Butorides virescens.*
Levinseniella adunca (Linton)	*Crocethia alba.*
Parorchis avitus Linton	*Larus argentatus.*
Galactosomum cochleariforme (Rudolphi)	*Fregata magnificens.*
Minuthorchis sanguineus, new genus and species	*Larus atricilla.*
Distomum sp. A	*Oidemia perspicillata.*
Distomum sp. B	*Oidemia perspicillata.*
Ornithobilharzia sp	*Larus argentatus.*
	philadelphia.
	Nycticorax nycticorax naevius.
	Oidemia deglandi.
Proalaria indistincta (Guberlet)	*Larus argentatus.*
	atricilla.
Alaria sp	*Larus delawarensis.*
Strigea bursigera (Brandes)	*Larus argentatus.*
	atricilla.
	delawarensis.

HAEMATOTREPHUS FODIENS, new species

Figures 1–6

Free in intestine and encysted in pancreas of a loon (*Gavia immer*).

Body of free worm nearly linear, narrowing slightly toward the anterior end; anterior half finely rugose; mouth small, terminal; anterior tip of body a subtriangular, muscular disk—the oral sucker; no ventral sucker certainly made out. Pharynx near mouth, pyriform; esophagus about twice the length of pharynx; intestinal rami extend to posterior end, where they appear to unite. Testes two, roundish, diagonally placed near the posterior end, and separated from each other by a space equaling or exceeding the diameter of a testis; seminal vesicle on the left side of the genital pore, which is on the median line at about the anterior sixth of the body. Ovary somewhat lobed, in front of the anterior testis and nearly on the median line. The seminal receptacle lies on the right posterior border of the ovary, and on the left anterior border of the first testis. The shell-gland lies along the anterior side and to the right, of the ovary. The uterus is very voluminous and fills the greater part of the interior of the body as far forward as the genital pore. Ova small and very numerous. The vitellaria lie between the lateral margins of the body and the intestinal rami, and extend from about the anterior fifth to near the posterior end.

Dimensions of free specimen in balsam: Length 11 mm.; breadth, at genital pore 1.40, at middle 1.85, at second testis 1.68, length of triangular head 0.21, breadth at base 0.35; pharynx, length 0.24, breadth 0.15; length of esophagus 0.45; ovary, length 0.22, breadth 0.70; first testis, length 0.35, breadth 0.56; second testis, length 0.40, breadth 0.52; ova 0.024 by 0.012.

Forms which were obtained from pedicelled cysts on the serous coat of the pancreas, although differing greatly in appearance from the free form, appear to belong to the same species. This form (fig. 3) is attenuate anteriorly, tapering from near the posterior end, where the breadth in one specimen was 0.80 mm. to a breadth of 0.05 mm. near the anterior end. The entire length of this worm was 15 mm. In this specimen the genital sucker is about 1.20 from the anterior end, and is 0.06 in diameter. The breadth of the body at the level of the genital pore is 0.12. In one of these attenuated forms the pharynx is 0.045 from the anterior end, length 0.045, breadth 0.03. The breadth of the body at the pharynx is 0.07. The testes are variable in shape, in some cases being distinctly lobed. The rami of the intestine, on account of their opaque contents, could be traced in a few cases to the posterior end of the worm, where they appeared to unite, although the actual continuation of the lumen from one to the other was not satisfactorily demonstrated. In the best preparation, although the terminations of the rami are contiguous, they did not appear to unite. The contents of each ended abruptly a short distance from the point of contact (fig. 6). Others removed from cysts, and more or less degenerated, did not show the contents of the intestinal rami approaching as closely as in the case figured. Ova in the free form, in the degenerate forms from cysts, and in cysts which contained only ova, are essentially similar in form and size.

On July 7, 1915, a loon (*Gavia immer*) was examined. It had been taken in a fish trap in Buzzard's Bay, and had been kept in the pool of the United States Bureau of Fisheries for a week before it died. The bird was reported by Vinal N. Edwards to have been "sick" when it was taken. The stomach and intestine were empty.

The pancreas was thickly peppered with dark brown cysts from 1 to 4 mm. in diameter, not of any uniform shape, but mostly rounded or subangular. They occurred on the surface under the serous coat, and also in the substance of the pancreas. The whole pancreas was affected, but not uniformly. At the point where the cysts were most abundant there were about 25 in a space 10 mm. square. When crushed these cysts were found to be filled with small ova. There was some variation in size but the dimensions in sea water were about 0.028 by 0.014 in the two principal diameters. It was noted that some of the ova had a cap at the smaller end. This feature has also been recognized in the mounted material. The maximum dimensions of ova in balsam are about 0.024 by 0.013.

The genital pore in the free form (fig. 1) has become indistinct in the mounted specimen on account of the encroachment of anterior folds of the uterus due to compression.

Type.—Cat. No. 7915, U.S.N.M.; paratype, Cat. No. 7916.

PSILOSTOMUM LINEATUM, new species

Figure 8

Two distomes collected from the intestine of a herring gull (*Larus argentatus*) at Woods Hole by Vinal N. Edwards, January 22, 1915, are here considered.

The longer of the two in formalin measured 5 mm. in length. In balsam the lengths are 3.78 and 2.66, respectively. They are nearly linear throughout with a breadth of about 0.5 mm.

Neck short, evidently much shortened by contraction in these specimens; ventral sucker much larger than oral; pharynx much smaller than oral sucker and contiguous with it; esophagus not plainly seen, but apparently very short; intestinal rami extend to the posterior end. The genital aperture was a little removed from the anterior edge of the ventral sucker and slightly to the left of the median line. In the specimen shown in Figure 8 the neck was somewhat distorted, so that the genital pore is thrown farther from the median line than it would be in an undistorted specimen. The cirrus-pouch is dorsal to the ventral sucker, and has rather weak walls; seminal vesicle relatively long, extending behind the ventral sucker. The two testes are on the median line and separated from each other by a space a little longer than the diameter of a testis. They are relatively large and nearly circular in outline. The anterior testis is a little way back of the middle of the length of the body. The ovary is about on the median line and near the anterior edge of the first testis. It is somewhat pestle-shape, with an elongated anterior lobe, while the broader posterior end is three lobed. There appears to be a seminal receptacle near the anterior edge of the ovary. The uterus lies between the ovary and the ventral sucker, the metraterm passing dorsal to the ventral sucker. The vitellaria are very diffuse, filling the body back of the testes, and extending in rather broad lateral bands as far forward as the posterior margin of the ventral sucker in one of the specimens, and to the level of the middle of the ventral sucker in the other. A vitelline reservoir was visible immediately in front of the ovary, and apparently ventral to the seminal receptacle.

Dimensions of larger specimen in balsam: Length 3.78 mm.; breadth 0.5; diameter of oral sucker 0.20; pharynx, length 0.14, breadth 0.10; diameter of ventral sucker 0.32; ovary, length 0.28, breadth of anterior lobe 0.10, at posterior end 0.15; first testis, length 0.38, breadth 0.30; second testis, length 0.46, breadth 0.38;

ova, collapsed and difficult to determine the exact diameters, longer diameter from 0.06 to 0.08, shorter diameter from 0.03 to 0.04.

Type.—Cat. No. 7917, U.S.N.M.

PSILOSTOMUM PLICITUM, new species

Figure 7

The following description is based on a single specimen mounted in balsam. It is from the intestine of a herring gull (*Larus argentatus*) and was collected at Woods Hole, but the date of collecting is missing.

Body elliptical in outline, longer than broad; margins of neck folded ventrally and projecting in front of the ventrally placed oral sucker; ventral sucker at about the anterior third and of about the same size as the oral sucker; pharynx relatively large, adjacent to oral sucker; esophagus none; rami of intestine begin at anterior edge of ventral sucker and extend to the posterior end; genital pore in front of ventral sucker, about at the level of the posterior end of the pharynx; cirrus-pouch at left side of ventral sucker, somewhat elongate, its posterior end functioning as a seminal vesicle; testes two, at about the posterior third, contiguous. The posterior testis is about on the median line, the anterior, for the most part, to the right of the median line. The ovary is at the antero-median border of the first testis. It is made up of small, rounded lobes, which give to it a morulalike effect. Near its postero-median border there is a seminal receptacle. The vitellaria fill the greater part of the body from the posterior end as far forward as the level of the middle of the ventral sucker. The uterus is between the ventral sucker and the ovary. The metraterm, dorsal to the ventral sucker, appears to have rather thick, muscular walls; ova few.

Dimensions in balsam: Length 1.68 mm; maximum breadth, about the middle, 0.84; diameter of oral sucker 0.20, of pharynx 0.13, of ventral sucker 0.18; ova 0.06 by 0.04.

Type.—Cat. No. 7918, U.S.N.M.

PSILOSTOMUM VARIUM, new species

Figure 9

A single distome, found in the inetstine of a loon (*Gavia immer*), at Woods Hole, September 1, 1911, is here described.

The following color notes were made on the living worm: General color effect purple. When the specimen was compressed the testes and ovary were seen to be a very brilliant magenta; the cirrus-pouch faint pink; rami of intestine throughout faint reddish; the very voluminous vitellaria dull, opaque magenta.

Dimensions, life, uncompressed: Length 1.68 mm.; breadth, anterior 0.21, middle 0.65; diameter of oral sucker 0.28, of pharynx 0.19(?), ventral sucker 0.42; ova 0.088 by 0.064. Length after compression 1.96.

Dimensions in balsam: Length 1.54; maximum breadth 0.70; diameter of oral sucker 0.21, pharynx 0.13, ventral sucker 0.33; ova 0.08 by 0.05.

Body more or less fusiform, bluntly rounded at extremities; ventral sucker much larger than oral, and placed at about the anterior third. It is provided with a sphincter, but does not appear to be as muscular as the oral sucker. Pharynx adjacent to oral sucker; esophagus none; rami of intestine extend to posterior end of the body. The cirrus-pouch is relatively large, thin-walled, long-pyriform, its posterior portion acting as a seminal vesicle. It is dorsal to the ventral sucker and extends for a short distance in front of the anterior border of the ventral sucker. The genital pore is about on the median line near the posterior border of the oral sucker. The testes are broader than long (length 0.13, breadth 0.27), contiguous, one following the other on the median line, about half way between the ventral sucker and the posterior end; ovary oval-elliptical in outline, a little to the left of the median line in front of the testes and near the ventral sucker, length 0.15, breadth 0.13. The vitellaria fill all the space back of the testes and extend in a broad band, approximately equal to one-third the breadth of the body, along each lateral margin to the level of the pharynx. The uterus lies between the first testis and the ventral sucker. It passes along the dorsal side of the ventral sucker a little to the right of the median line, and parallel with the seminal vesicle, to the genital pore. The ova are large, and, considering their size, rather many—approximately 75.

The most conspicuous feature in the mounted specimen is the widely diffused, brownish red vitelline gland. In life the most striking characteristic was the differential coloration.

Type.—Cat. No. 7919, U.S.N.M.

PETASIGER NITIDUS, new species

Figures 10–16

From intestine of horned grebe (*Colymbus auritus*).

Small, fusiform; head reniform with 19 spines in a single circle uninterrupted dorsally; length of spines at ventral angles of head 0.14, elsewhere 0.12; neck concave ventrally, densely covered with small spines becoming sparingly scattered on the body; ventral sucker near the middle of the length, much larger than the oral sucker; pharynx longer than broad, separated from the oral sucker by a short prepharynx; esophagus long; rami of the intestine begin

at about the level of the anterior border of the ventral sucker and extend to the posterior end of the body. The genital pore is at the anterior border of the ventral sucker a little to the left of the median line. Testes two, contiguous, diagonally placed, about half way between the center of the ventral sucker and the posterior end; cirrus-pouch and seminal vesicle dorsal to the anterior border of the ventral sucker. Ovary subglobular, at right anterior border of testes; uterus in front of ovary and testes, the ova relatively few and lying mainly between the testes and the ventral sucker, but a few usually in the metraterm dorsal to the ventral sucker, about 0.084 by 0.054 in the two principal diameters. The vitellaria are diffuse and extend from the level of the genital pore nearly to the posterior end. Excretory vessel behind the testes spacious

From a series of transverse sections the following interpretations were made: In one section near the posterior edge of the ventral sucker, the opening of Laurer's canal was seen on the dorsal side of the section. In the next two sections the canal is seen passing ventrad along the right side of the first testis. It then turns to the dorsal side of the testis, and, proceeding dorso-sinistrad, enters the shell-gland, which lies for the most part on the left side of the ovary. In the fourth section the germ duct and the vitelline duct from the transverse vitelline reservoir, which lies along the dorsal side of the testis, between it and the postero-ventral border of the ovary, were seen entering the shell-gland. In the first of these four sections an ovum was observed in the oviduct still within the shell-gland.

The neck in all the preserved material is strongly flexed ventrad, and measurements are consequently rather difficult to make.

Following are dimensions of a specimen in balsam: Length 1.96 mm.; maximum breadth (at ventral sucker) 0.63; breadth of head, excluding spines, 0.28, of neck 0.21; oral sucker, length 0.105, breadth 0.063; ventral sucker, length 0.31, breadth 0.34; pharynx, length 0.096, breadth 0.051; ova 0.09 by 0.05. The ventral sucker is 0.7 mm. from the anterior end and the testes 0.5 from the posterior end. In another specimen the oral spines had the following dimensions: Spines at ventral angles of the head, length 0.144 to 0.150, breadth 0.024; lateral spines, length 0.105 to 0.120, breadth 0.018.

Type and paratype.—Cat. No. 7920, U.S.N.M.

RECORD OF COLLECTIONS

Colymbus auritus.

1905, December 25. 60. Uniformly short and plump. Dimensions in formalin: Length 1.47; breadth, anterior 0.33, middle 0.56, posterior 0.16; diameter of oral sucker 0.09, of pharynx 0.05, of ventral sucker 0.30; ova 0.088 by 0.054.

1915, January 7. 104. Dimensions in formalin: Length 2.25; diameter of head, including spines, 0.45, of neck 0.30, of body at middle 0.70, near posterior end 0.22.

HIMASTHLA ELONGATA (Mehlis)

Figures 17–20

1831. *Distomum elongatum* MEHLIS, Isis, p. 177.
1892. *Echinostomum elongatum* (Mehlis) STOSSICH, Boll. Soc. adriat. Sc. nat. Trieste, vol. 13, p. 39.
1909. *Distomum elongatum* (Mehlis) DIETZ, Zoolog. Anzeig., vol. 34, p. 184. *Himasthla clonga* (Mehlis) DIETZ, Die Echinostomiden d. Vogel. Inaug. Diss., Konigsberg, p. 16.
1910. DIETZ, Zoolog. Jahrb., Suppl. 12, pp. 360–363, pl. 13, fig. 25.

Larus argentatus, *L. marinus*, *L. ridibundus*.

Woods Hole, Mass.: *Larus argentatus*, *L. delawarensis*, *L. marinus*, *L. philadelphia*, *Nycticorax nycticorax*, intestine.

These distomes, while they vary considerably in size and proportions, appear to belong to the same species, and are in such close agreement with *H. elongata* that it seems best to refer them to that species in spite of the difference in the number of circum-oral spines.

H. elongata is characterized by having 29 circum-oral spines, of which the two which are situated at each angle of the oral disk are smaller than the others. In all the specimens in which they could be distinctly seen in the Woods Hole material, the number of oral spines was found to be 31, arranged as shown in Figure 18. Furthermore, there is little difference in the length of the spines. The apparent difference in the camera lucida sketches is due to foreshortening.

Body slender, nearly linear, neck spinose, concave on ventral side; oral sucker ventro-terminal, small, surrounded by a reniform, spine-bearing disk. The circle of spines is interruped below so as to have a somewhat horseshoe shape. The number of oral spines is 31, of which 27 are around the border and 2 at each posterior angle of the disk. The spines differ little in size, the length being about 0.054, breadth 0.014. Pharynx near the oral sucker, longer than broad; esophagus slender; rami of intestine begin at anterior border of ventral sucker and extend to the posterior end of the body; ventral sucker much larger than oral, in some cases nearly circular in outline, in others longer than broad. Genital pore on median line at anterior border of ventral sucker; cirrus long and covered with spines; cirrus-pouch elongate and posterior to ventral sucker, with a spacious seminal vesicle at its posterior end. In a series of

tangential sections the seminal vesicle is 0.56 mm. in length and 0.20 in diameter. Testes near the posterior end of the body, one following the other, in most cases elliptical in outline and much longer than broad; ovary subglobular, nearly on the median line, or a little to the right, a short distance in front of the first testis, from which it is separated by the rather conspicuous shell-gland and vitelline reservoir, and beginning of the uterus. Laurer's canal was traced from its opening on the dorsal surface, at the level of the ovary, to the vicinity of the beginning of the uterus, which appeared to contain sperm and germ cells associated with ova while still enveloped by the shell-gland. The vitellaria begin a little in front of the base of the seminal vesicle and extend along the lateral margins to the level of the posterior end of the second testis. Back of this point the vitellaria in most cases fill the body. In transverse sections the excretory vessel is seen to divide at the second testis into a right and left branch, which could be traced forward to the ovary, but are difficult to distinguish in sections through the uterus, where, with the exception of a small area at each side occupied by the vitellaria, the interior is filled with ova. The uterus fills the central region of the body from the ovary to near the seminal vesicle. Thence forward it is a straight duct, the metraterm, which passes on the dorsal side of the ventral sucker and opens at the genital pore immediately in front of the cirrus. The ova measure from 0.08 to 0.11 mm. in the longer, and from 0.05 to 0.06 in the shorter diameter.

Following are tabulated measurements of balsam mounts from different hosts.

	Larus argentatus			Larus delawarensis	Larus marinus	Larus philadelphia	Nycticorax nycticorax
Length	10.00	3.64	6.58	5.46	7.00	8.00	6.50
Maximum breadth	.42	.63	.63	.35	.63	.84	.50
Diameter of head	.30	.32	.39	.20	.27	.28	.28
Diameter of oral sucker	.08	.11	.11	.11	.09	.10	.09
Length of pharynx	.09	.09	.11	.11	--------	.15	.08
Breadth of pharynx	.05	.06	.07	.08	--------	.10	.06
Diameter of ventral sucker	.28	.28	.35	.27	.28	.35	.28
Length of first testis	.72	.25	.42	.42	.65	------	.29
Breadth of first testis	.25	.25	.35	.20	.35	------	.21
Length of second testis	.80	.24	.49	.39	.70	------	.39
Breadth of second testis	.25	.28	.35	.20	.20	------	.23
Diameter of ovary	.15	.17	.20	.13	.18	------	.13
Distance of ventral sucker from anterior end	.30	.45	.73	.56	.30	.42	.64
Distance of second testis from posterior end	.63	.31	.59	.28	.56	------	.77
Ovum, longer diameter	.105	.09	.10	.11	.105	.10	.096
Ovum, shorter diameter	.06	.05	.05	.06	.063	.54	.051

RECORD OF COLLECTIONS

Larus argentatus.

1912, February	16.	25.
	17.	28.
	19.	2.
1913, January	30.	30. 10 mm., more or less.
November	3.	1, and fragment.
	17.	1.
	21.	4. Two of these were exceedingly slender, 15 and 20 mm. in length respectively, filiform for a good part of the length.
1914, January	10.	1.
	22.	12.
September	10.	385. The largest, in sea water, measured 8 mm. in length and 0.65 in breadth. A small immature specimen measured 1.27 in length and 0.60 in breadth.
December	16.	3. Maximum length, in formalin, 8.5.
	23.	Number not recorded, slender, linear from 5 to 15 mm. in length.
1915, January	22.	267, young and adult.
February	18.	4, young.
September	29.	1. Length in formalin 5.25, maximum diameter, at level of testes, 0.56.
November	10.	4, maximum 7 mm.
1916, January	8.	11. Attenuated, longest 11.5 mm.
February	17.	1 and fragment.
March	9.	69 and a few fragments.
1917, January	18.	11 and fragments.
1920, December	18.	129, largest, in alcohol, length 7 mm. Collected by R. A. Goffin. (Cat. No. 7921, U.S.N.M.)

Differences in length of adult worms are due mainly to the degree of development of the uterus.

This is shown by the following measurements made on four specimens in which ova had made their appearance in the uterus, which is limited to the space between the ventral sucker and the ovary.

Length	Distance from anterior end to posterior end of ventral sucker	Distance from ventral sucker to ovary	Distance from ovary to posterior end
9.14	0.60	5.88	2.66
7.37	1.05	3.78	2.54
3.68	.84	1.82	1.02
3.15	.77	1.43	.95

Larus delawarensis.
1914, January 24. 11. These distomes are rather more slender than are those from the other species of gull. In a series of sections the cirrus appears to be smooth. The ova are large, 0.11 by 0.06 in a whole mount, and from 0.08 by 0.04 to 0.12 by 0.05 in sections. (Cat. No. 7922, U.S.N.M.)

Larus marinus.
1922, January 10. 1. (Cat. No. 7923, U.S.N.M.)

Larus philadelphia.
1913, April 13. 1, fragment, posterior end missing.

Nycticorax nicticorax naevius.
1914, September 11. 1. (Cat. No. 7924, U.S.N.M.)

HIMASTHLA INCISA, new species

Figures 21–33

From intestine of white-winged scoter (*Oidemia deglandi*).

Head reniform and surrounded by a circle of about 27 spines uninterrupted dorsally; neck short, concave beneath, densely covered with minute spines set in transverse rows. Margins of neck finely serrate, the serrations becoming more marked posteriorly, the body from a level a little back of the ventral sucker to near the posterior end being transversely and sharply corrugated. Body nearly linear, and rather slender. Oral sucker nearly circular; pharynx longer than broad, near oral sucker; ventral sucker circular and much larger than oral. In sections there appeared to be a short esophagus, although none could be seen in the whole mount. The intestinal rami extend to the posterior end of the body. The genital pore opens immediately in front of the ventral sucker; cirrus-pouch and seminal vesicle extend far back of the ventral sucker; in the mounted specimen the posterior end of the seminal vesicle was 1.25 mm. back of the ventral sucker. The testes are oval-elliptical, one following the other, and near the posterior end of the body. The subglobular ovary is situated a little to the right of the median line in front of the first testis, from which it is separated by the relatively large shell-gland, vitelline reservoir, and beginning of the uterus. The vitellaria are abundant and extend from the posterior end of the body to within a short distance (0.5 mm. in the mounted specimen) of the ventral sucker. The uterus fills the central space between the vitellaria from the ovary nearly to the seminal vesicle, from which point the metraterm leads to the genital pore; ova rather numerous, about 0.112 by 0.057 in the two principal diameters. Some details

of the anatomy are shown in the figures. Laurer's canal opens dorsally on the median line on a level with the posterior border of the ovary. It passes laterad along the dorsal border of the ovary, then turns medio-ventrad to the uterus, the earlier portions of which contain sperm. The excretory vessel behind the second testis is spacious. It divides at the posterior end of the second testis. The exact number of oral spines could not be made out in the balsam mount. There are at least 27. There is a single row, except at the lateral angles. (Fig. 23, sketched from a transverse section.) The longest spine measured 0.051 in length and 0.018 in breadth, shorter spine 0.039 in length and 0.012 in breadth. A striking character in the structure of the body wall is the layer of longitudinal muscle fibers. These are indicated in the sketches of transverse sections. (Figs. 32, 33.)

Dimensions of specimen mounted in balsam: Length 9 mm.; breadth, at level of ventral sucker 0.63, at ovary 1.17, 1 millimeter from posterior end 0.91; oral sucker, length 0.11, breadth 0.10; pharynx, length 0.09, breadth 0.056; ventral sucker, diameter 0.38; distance of anterior border of ventral sucker from anterior end 0.35; diameter of ovary 0.28; first testis, length 1.12, breadth 0.35; second testis, length 1.05, breadth 0.40. In a series of sections: Diameter of oral sucker 0.12; pharynx, length 0.10, breadth 0.08; diameter of ventral sucker 0.31.

Type.—Cat. No. 7925, U.S.N.M.

RECORD OF COLLECTION

Oidemia deglandi.

1914, June 2. 2. The living worms red, according to record of Vinal N. Edwards, collector.

MESORCHIS PSEUDOECHINATUS (Olsson)

Figures 34–42

1876. *Distomum pseudoechinatum* OLSSON, Svensk, Vetensk. Akad. Handl., vol. 14, p. 21, pl. 4, figs. 45–49.

1892. *Echinostomum pseudoechinatum* Olsson STOSSICH, Boll. Soc. adriat. Sc. nat., Trieste, p. 166 (p. 24 of reprint).

1898. ——— ——— MUHLING, Arch. Naturg., Jg. 64, vol. 1, p. 21.

1899. *Echinostomum pseudoechinatum* Olsson STOSSICH, Boll. Soc. adriat. Sc. nat., Trieste, vol. 19, p. 13.

1899. *Echinostomum pseudoechinatum* (Olsson) LOOSS, Zoolog. Jahrb., vol 12, Syst., pp. 685–686, pl. 25, figs. 11, 12, 15*a*.

1909. *Echinostomum (Mesorchis) pseudoechinatum* (Olsson) DIETZ, Zool. Anz., vol. 34, p. 183.

1909. *Mesorchis pseudoechinatus* (Olsson) DIETZ, Inaug, Diss., Konigsberg, p. 31.

1910. ——— ———, Zool. Jahrb. Sup. 12, p. 451–452.

Larus marinus.

Woods Hole, Mass.: *Larus argentatus*, *L. atricilla*, *L. delawarensis*, *L. marinus*, *L. philadelphia*, *Colymbus auritus*, *C. holbölli*, *Gavia immer*, intestine.

These distomes from the intestines of five species of gull, two species of grebe, and the loon appear to be the same species as that described by N. C. Gilbert from the loon.[1] They agree in the following characters: Oral sucker small, head reniform, surrounded by a single circle of spines interrupted on the dorsal side. The number of spines in the oral circle is 22, and they are of nearly equal size, length 0.065 to 0.07, breadth 0.015 to 0.020. The postero-median spines on each side are a little smaller than the others. Neck and anterior part of the body spinose; neck, except in relaxed and partly macerated specimens, rather short and more or less tapering; body usually nearly linear, but in some cases thickening in the vicinity of the testes or ventral sucker. There is a short prepharynx; pharynx longer than broad, its length approximating the diameter of the oral sucker; esophagus longer than pharynx; intestinal rami begin a short distance in front of the ventral sucker and extend to the posterior end of the body; ventral sucker from two to three times the diameter of the oral sucker. Testes two, following one another, either contiguous or separated, and either oval-elliptical, quadrilateral, or subtriangular in outline, depending on age and condition. In many cases the first testis is quadrilateral and the second subtriangular. In a few cases the testes were slightly diagonal, apparently not due entirely to distortion of the body. Those cases in which the testes were oval-elliptical, and separated from each other, were more or less flaccid, some of them even showing signs of maceration. They had lost both oral and body spines. The cirrus-pouch and seminal vesicle are short and at the antero-dorsal surface of the ventral sucker. The ovary, usually subglobular, is a little way in front of the first testis, from which it is separated by a short space in which lie the transverse yolk reservoir, the shell-gland, and the beginning of the uterus. The uterus lies between the ovary and the ventral sucker. Ova not numerous, in balsam measuring from 0.081 to 0.09 in the longer, and from 0.048 to 0.054 in the shorter diameter. The vitellaria are massed in the posterior end of the body, which is more or less elongated, behind the testes, and extending forward, in some cases not beyond the posterior margin of the second testis, in others extending to different levels on one or both sides of the testes, but not extending in front of the first testis. In older individuals there is a clear space on the median line back of the testes separating the vitellaria into two lateral masses. In young, robust individuals

[1] Occurrence of Echinostomum spinulosum Rudolphi, Amer. Nat., vol. 39, pp. 925–927.

the post-testicular region is filled completely with the vitellaria. Usually the testes are situated a little in front of the middle of the post-acetabular region of the body.

Average length of 24 specimens in balsam 3.93, average maximum breadth of same 0.43. Of these the longest measured 6.13 in length and 0.49 in breadth; the shortest, 1.44 in length and 0.22 in breadth; the broadest, 2.52 in length and 0.68 in breadth; the narrowest, 1.44 in length and 0.22 in breadth. Transverse diameter of oral sucker, average of 18 in balsam, 0.11, of pharynx 0.06, of ventral sucker 0.27; length of pharynx, 0.10.

Dimensions of testes, average of 13, in balsam: First testis, length 0.32, breadth 0.32; second testis, length 0.39, breadth 0.33; shortest first testis, length 0.14, breadth 0.42; longest first testis, length 0.55, breadth 0.34; shortest second testis, length 0.20, breadth 0.38; longest second testis, length 0.67, breadth 0.42.

Anterior limits of vitellaria in 30 mounted specimens: Anterior edge of first testis 6; between the middle and anterior edge of first testis 13; between posterior edge and middle of first testis 10; posterior edge of second testis 1. Distance of posterior margin of second testis from anterior end, average of 29, 2.04; same from posterior end 1.54, a ratio of 4 to 3. Departures from this ratio were: 2.10 to 2.59, or a ratio of 4 to 5, and four cases where the ratio was 2 to 1. The greatest departure from the ratio 4 to 3 is the example from the loon (fig. 42), where the ratio is 1.74 to 0.36, or nearly 5 to 1. This specimen suggests Dietz's *Monilifer spinulosus* (Rudolphi).

RECORD OF COLLECTIONS

Larus argentatus.

1913, April 8. 14. Note on formalin material: Anterior half of body white, posterior filled with vitellaria, bluish; larger example, length 5.80, breadth 0.64; smaller example, length 3.80, breadth 0.38.

1915, August 13. 5. (Cat. No. 7926, U.S.N.M.)

September 1. 1.

1917, January 17. 1.

18. 28. In the younger individuals the testes are contiguous, the anterior more or less quadrangular, the posterior somewhat triangular in outline. In the older specimens the testes are elliptical in outline and are separated by a short interval. Dimensions in balsam: Length 3.5; diameter of head 0.30; maximum diameter, a little way back of ventral sucker,

0.56; diameter of oral sucker 0.10, of pharynx 0.06, of ventral sucker 0.24; length of pharynx 0.10; ovum 0.08 by 0.05; length of oral spines about 0.07, breadth about 0.02.

1927, August 13. 1.

Larus atricilla.

1904, August 12. 2 gulls examined, 2 distomes from one, 1 from the other; ova 0.080 by 0.058.

1911, July 24. 2. Dimensions, balsam: Length 3.32; maximum breadth 0.46; diameter of head 0.22, of oral sucker 0.11, of pharynx 0.07, of ventral sucker 0.25; length of pharynx 0.09; ovary, length 0.16, breadth 0.21; first testis, length 0.29, breadth 0.31; second testis, length 0.59, breadth 0.38. (Cat. No. 7927, U.S.N.M.)

Larus delawarensis.

1914, January 24. 9. Note on formalin material: Slender, flaccid, and slightly macerated; most of the oral spines and all of the body spines missing. Dimensions in balsalm: Length 6.45; maximum breadth 0.39; diameter of oral sucker 0.09, of pharynx 0.06, of ventral sucker 0.27; length of pharynx 0.09; diameter of ovary 0.14; first testis, length 0.36, breadth 0.25; second testis, length 0.67, breadth 0.24; ovum 0.087 by 0.051. (Cat. No. 7928, U.S.N.M.)

Larus marinus.

1914, April 28. 2. Length, in balsam, 4 mm. As nearly as can be made out there are 22 spines around the mouth, 0.069 in length and 0.018 in breadth. The neck is thickly beset with stout spines arranged in diagonal rows. There is a space on the neck of about 0.15 between the oral spines and the neck spines which is smooth. The spines become sparse toward the base of the neck, but may be seen along the margin of the body back to a point opposite the middle of the posterior testis. The testes are situated at about the middle of the length of the body, contiguous with each other in one, separated by a short space in the other. In ventral view the anterior testis is elliptical in outline, but with its anterior border nearly straight, breadth 0.49, length 0.25; posterior

testis somewhat triangular in outline, breadth 0.49, length 0.35. In lateral view the testes are somewhat quadrilateral in outline. (Cat. No. 7929, U.S.N.M.)

Larus philadelphia.

1912, November 15. 1. Length in balsam 4.62.

December 21. 5. From 3 to 4 mm. in length. (Cat. No. 7930, U.S.N.M.)

1914, November 13. 8. Slender, longest about 4 mm.

Colymbus auritus.

1905, December 25. 2. Length in formalin 4.5 mm.

Colymbus holbölli.

1914, February 18. 2. Lengths approximately 2.5 and 4 mm. In each the diameter of the oral sucker is 0.14, of the ventral sucker 0.28; ovum 0.08 by 0.05; length of oral spines 0.07. One of the worms is slender, length 4 mm.; maximum breadth, at level of testes 0.38; first testis, length 0.28, breadth 0.24; second testis, length 0.35, breadth 0.24. The other is fusiform (fig. 41), length 2.5 mm.; maximum diameter 0.64; first testis, length 0.14, breadth 0.42; second testis, length 0.24, breadth 0.29. (Cat. No. 7931, U.S.N.M.)

Gavia immer.

1911. July 24. 5. These distomes, while differing considerably in the proportions of the body behind the testes, agree in all essentials with those from the herring gull. Lengths, in balsam, from 1.50 to 3.15 mm., breadths from 0.21 to 0.38. The ratio of the portion of the body behind the testes to that in front of the testes varies from 1:1 to 2:1. The vitellaria extend to the anterior edge of the first testis in one, to the posterior edge of the first testis in another, and to about the middle of the first testis in the others: ova 0.09 by 0.054. (Cat. No. 7932, U.S.N.M.)

September 1. 1. This specimen differs from those of the foregoing date in the relatively short post-testicular region. (Fig. 42.) Dimensions in balsam: Length 2.20; breadth 0.70; diameter of oral sucker 0.13, of pharynx 0.08, of ventral sucker 0.30; length of pharynx 0.10, of ven-

tral sucker 0.24; ova 0.087 by 0.054; oral spines about 0.06 in length and 0.018 in breadth. (Cat. No. 7933, U.S.N.M.)

This specimen suggests Dietz's *Monilifer spinulosus* Rudolphi (Zool. Jahrb. Sup. 12, pp. 465–470, pl. 15, fig. 51) and Looss's *Echinostomum euryporum* Looss (Zool. Jahrb. 12, pp. 686–7, pl. 25, figs. 16, 17).

1913, December 31. 1. In formalin, length 2.85, breadth 0.55. Dimensions in balsam: Length 1.96; maximum breadth, at level of testes, 0.45; diameter of oral sucker 0.12, of pharynx 0.07, of ventral sucker 0.28; length of pharynx 0.10; ova 0.078 by 0.054.

APORCHIS RUGOSUS, new species

Figures 43–49

A distome from the intestine of an Arctic tern (*Sterna paradisea*) at Woods Hole, August 17, 1912, although no oral spines were present, is referred to Fuhrmann's genus *Aporchis*.

Dimensions in life: Length 17 mm.; breadth, anterior 0.22, at ventral sucker 0.44, about middle of length 0.73, towards posterior end, maximum, 1.12; ovum, exclusive of the long filament, 0.11 by 0.03.

Body elongate, slender, tapering gradually to the anterior end from a point near the posterior end, which is very slightly narrowed and bluntly rounded. Mouth subterminal, head reniform; no oral spines present, but what were interpreted as faint indications of evanescent spines were seen. Neck covered with blunt, papillate spines in close, transverse rows. Spines on anterior part of the body rather irregularly placed, becoming sparse at level of anterior limits of the vitellaria. On the lateral margins these papillate spines are very irregular (fig. 47), and show a tendency to slough off. The posterior third of the body is distinctly serrate on the lateral margins. (Fig. 48.)

Dimensions in balsam: Length 16 mm.; breadth of head 0.17, at level of ventral sucker 0.35, at middle of length 0.70, near posterior end 0.80; diameter of oral sucker 0.09, of pharynx 0.05, of ventral sucker 0.22; ovary, length 0.14, breadth 0.26; first testis, length 0.22, breadth 0.39; second testis, length 0.25, breadth 0.35; ova from 0.08 to 0.11 in length, excluding the long filament, and about 0.03 in the shorter diameter; distance of anterior border of ventral sucker from anterior end 0.35.

The pharynx is pyriform, a little longer than broad, and contiguous to the oral sucker. The esophagus extends to the anterior border of the ventral sucker; rami of intestine reach to the posterior end of the body; genital pore at the anterior border of the ventral sucker, a little to the left of the median line. The cirrus appears to be smooth; cirrus-pouch slender, on the dorsal side of the left border of the ventral sucker, about 0.5 in length, not including its continuation into the seminal vesicle, which is about 0.17 mm. in length. Testes two, near together on the median line, and near the posterior end of the body; second testis 0.6 mm. from the posterior end. Ovary oval, with the longer diameter transverse, in front of testes, most of it to the right of the median line. The ovary is separated from the first testis by a short space in which lie the shell-gland, seminal receptacle, vitelline ducts, and the beginning of the uterus. In front of the testes, for a distance of about 8.5 mm. the folds of the uterus, crowded with ova, fill the body between the marginal vitellaria. For a considerable distance behind the ventral sucker the uterus is somewhat tortuous in its course to the genital pore. Near the ventral sucker it lies dorsal and median to the cirrus-pouch. The vitellaria are lateral and lie in a narrow line along each lateral margin from a point near the middle of the length to a short distance in front of the ovary.

A distinctive feature of the stained and mounted specimen is the occurrence of strong longitudinal muscle bundles from the level of the ventral sucker to the posterior end. Behind the testes about 24 of these bundles could be seen. The peculiar papillate spines are also a conspicuous character. The filament, attached to an ovum, is very long. The example illustrated (fig. 49) was lying isolated from other ova in the metraterm, and the filament was traced with the aid of a camera lucida.

Type.—Cat. No. 7934, U.S.N.M.

STEPHANOCHASMUS species

On August 15, 1913, a kingfisher (*Ceryle alcyon*) was examined at Woods Hole. The only parasite found was an encysted distome in the stomach. The stomach of the bird was filled with small fish (*Menidia notata*).

Since the worm was still enclosed in its cyst, and associated with recently ingested food, with which it was probably introduced, it will be best not to regard the kingfisher as a final host of this parasite.

Diameter of cyst in sea water 1.12 mm. Dimensions in balsam, specimen compressed: Diameter of cyst 1.16; length of distome 1.96; diameter, lateral view, anterior 0.14, at pharynx 0.21, at ventral

sucker 0.29, near posterior end 0.58; oral sucker, length 0.11, diameter 0.11, pharynx, length 0.17, diameter 0.13; ventral sucker, length 0.29, diameter 0.21. There is a double row of spines around the mouth. The neck is covered very densely, and the body less densely with short spines. (Cat. No. 7935, U.S.N.M.)

CRYPTOCOTYLE LINGUA (Creplin)

1825. *Distoma lingua* CREPLIN, Observationes de entozois, pp. 47–48 (in *Larus marinus*, var. *maximus*).

1899. *Tocotrema lingua* (Creplin), LOOSS, Zool. Jahrb. Syst., vol. 12, p. 586.

1903. *Crypthocotyle lingua* (Creplin), FISCHOEDER, Zool. Jahrb. Syst., vol. 17, p. 548.

1905. *Dermocystis ctenolabri* STAFFORD, Zool. Anz., vol. 28, p. 682 (in gills and skin of *Ctenolabrus adspersus*).

1918. *Hallum caninum* WIGDOR, Journ. Amer. Vet. Med. Assn., Baton Rouge, La., pp. 254–257 (intestine of dog).

1920. *Cryptocotyle lingua* (Creplin, 1925) FISCHOEDER, 1903, Ransom, Proc. U. S. Nat. Mus., vol. 57, pp. 544–548; bibliography, pp. 570–573.

Woods Hole, Mass.: Adult stage in intestine of *Butorides virescens*, *Colymbus auritus*, *Gavia immer*, *Larus argentatus*, *L. delawarensis*, *Nycticorax nycticorax*, *Sterna dougalli*, *S. hirundo*. Encysted in gills, fins, and skin of *Ctenolabrus adspersus*, *Tautoga onitis*, and other species of fish.

This distome has already been made the subject of a report (Linton. *Tocotrema lingua* (Creplin), Jour. Parasit., March, 1915, vol. 1, pp. 128–134, text figures 1 to 3B).

RECORD OF COLLECTIONS

In the report cited a list of the hosts, in which this worm was found in the alimentary canal, was given. Following are additions to the record of collections reported in 1915:

Butorides virescens.

1912, August 2. 1, young; length 0.40, breadth 0.18. The stomach of the heron was filled with nearly digested fish, among which a cunner (*Tautogolabrus adspersus*) was noted. Plainly the distome had survived the removal of the cyst in which it had doubtless been enclosed when introduced with the food.

Gavia immer.

1915, July 7. Few.

August 11. Very numerous. The intestine of the loon, throughout almost its whole length, was thickly peppered with these worms, visible as minute, dark specks, on account of the clusters of dark brown eggs in the uterus.

1916, July	4.	Many; 602 counted.
Larus argentatus.		
1914, January	22.	Many; 1,504 counted.
1915, January	22.	Many; 357 counted.
February	18.	1.
October	5.	25.
1916, January	6.	1.
	8.	23.
1917, January	18.	104. Vinal Edward's note was: "Many small worms."
1927, August	13.	113, from intestines of 2 gulls.
Larus atricilla.		
1911, August	15.	Recorded, but number not given, adult. (Cat. No. 7938 U.S.N.M.)
Larus delawarensis.		
1914, January	24.	2, adult with ova; length 1.33 breadth 0.46; ova 0.04 by 0.02. (Cat. No. 7939, U.S.N.M.)

ASCOCOTYLE PLANA, new species

Figure 50

Two small distomes, collected from the intestine of a green heron (*Butorides virescens*), at Woods Hole, September 11, 1912, although they are devoid of the circle of spines around the oral sucker, and of spines on the body, which are characteristics of Looss's genus Ascocotyle,[2] are in such close agreement in other respects with that genus that it seems best to regard the spines as an evanescent character.

Outline of body ovate, tapering to the anterior end, bluntly rounded posteriorly, broadest at about the posterior third. Oral and ventral suckers small, about equal, each a little broader than long; pharynx nearly cylindrical, a little longer than broad; prepharynx ample, somewhat saclike; esophagus slender; intestinal rami short, reaching barely to the level of the anterior border of the ventral sucker, which is situated at about the middle of the length of the body. Genital aperture on median line at anterior edge of ventral sucker; cirrus-pouch dorsal and to the left of the ventral sucker; seminal vesicle large, on median line behind ventral sucker, from which it is separated by a space greater than the diameter of the ventral sucker. The two testes are situated at the posterior end, transversely placed, their inner ends closely apposed at the median line, their transverse diameter much greater than the longitudinal; ovary a little to the right of the median line, between the right testis

[2] Zool. Jahrb., 1899, pp. 698–9, pl. 26, fig. 23.

and the seminal vesicle. There is a small seminal receptacle at the postero-median edge of the ovary. The vitelline glands are at the postero-lateral margins of the body. They are somewhat irregular in outline, rather compact, the length of each a little less than half the length of the post-acetabular region. The uterus occupies practically all the space in front of the testes and vitellaria as far as the level of the anterior border of the ventral sucker, except what is taken up by the ovary and seminal vessels. The ova, which fill this space, are golden yellow, except in the vicinity of the ovary, where they are thin-shelled, and have taken the stain. The mass of ova prevents the making out of further details of structure.

Dimensions of larger specimen, life: Length 0.75 mm.; maximum breadth 0.34; breadth of oral sucker 0.051, of ventral sucker 0.054; pharynx, length 0.05, breadth 0.03; ova 0.02 by 0.01.

Dimensions in balsam: Length 0.67; maximum breadth 0.32; oral sucker, length 0.03, breadth 0.04; pharynx, length 0.030, breadth 0.027; ventral sucker, length 0.036, breadth 0.045; prepharynx, length 0.09, breadth 0.03; esophagus, length 0.075, breadth 0.012; testes 0.096 by 0.054 and 0.090 by 0.045; ovary, length 0.072, breadth 0.063; ova 0.020 by 0.012.

Type.—Cat. No. 7940, U.S.N.M.

LEVINSENIELLA ADUNCA (Linton)

Figure 51

1905. *Distomum aduncum* LINTON, Bull. U. S. Bureau of Fisheries, vol. 24, p. 409, figs. 195–197, intestine of *Opsanus tau*.

Following are a few details, mainly from notes made at the time of collecting, of a small distome from the intestine of a Sanderling (*Crocethia alba*) shot near Cape Lookout, N. C., by Dr. John D. Milligan of the steamer *Fish Hawk*, August 15, 1902. It was noted that the distome appeared to be identical with a species found in the toad fish (*Opsanus tau*), at Beaufort, N. C. The specimen had lain in sea water over night before it was examined and the ventral and genital suckers were rather faintly shown.

Dimensions in sea water, compressed: Length 0.8 mm.; breadth, anterior 0.09, at posterior third, maximum, 0.35; diameter of oral sucker 0.06, of pharynx 0.04, of ventral sucker 0.05, of genital sucker 0.056; ova 0.018 by 0.012.

An examination of the stained specimen showed the testes and vitellaria, and they were added to the sketch which had been made of the worm while it was in sea water. The mounted specimen is in poor condition, and but little of the anatomy is shown. (Cat. No. 7941, U.S.N.M.)

PARORCHIS AVITUS Linton

This distome, from the cloaca of the herring gull (*Larus argentatus*), was reported in 1912.[3] (Cat. No. 7942, U.S.N.M.)

Prof. William Nicoll has written me suggesting that this is the same as *Zeugorchis acanthus* (renamed by Nicoll *Parorchis acanthus*), found by him in the bursa Fabricius and cloaca of the herring gull.[4] I hesitate, however, at present to make any change in my classification for the following reasons:

Braun in 1901 gave the name *Distomum pittacium* to a distome, represented by a single specimen from *Tringa interpres*.[5] The main difference between *D. pittacium*, on the one hand, and *P. acanthias* and *P. avitus* on the other, is the absence of spines and of a circumoral collar. The absence of spines is an unimportant difference, as they may be more or less evanescent. The absence of a circumoral collar is harder to account for, but, since Braun had only the one specimen, and that possibly not in the best state of preservation, it is certain, in view of the very close resemblance in details of anatomy in these three differently named distomes, that they are very closely related, if not identical species.

Nicoll notes the remarkable resemblance between *D. pittacium* and *P. acanthias*, but indicates certain points in which they differ. Thus the ratio of the diameter of the oral sucker to the ventral sucker in *D. pittacium* is 1:3, while in *P. acanthias* it is nearly 1:2. In *P. acanthias* the pharynx is slightly larger and the testes much smaller than in *D. pittacium*. The convolutions of the uterus are much more extensive in *D. pittacium* than they are in *P. acanthias*, extending, as they do, to the lateral margins of the body, as well as anteriorly to about the level of the middle of the ventral sucker, and posteriorly to a level behind the testes.

A reexamination of four specimens mounted in balsam shows that with respect to the uterus *P. avitus* is in almost exact agreement wih *D. pittacium*. In all of them the convolutions of the uterus extend to the lateral margins. In all of them, also, convolutions lie on each side of the ventral sucker from about its posterior fourth to the posterior third of its length. In two of the four specimens convolutions of the uterus extend back to the middle of the testes, in one they extend to the posterior end of each testis, and in one they extend a little way back of the testes, as they do in the type specimen.

Measurements of four specimens mounted in balsam, all more or less compressed.

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[3] Proc. U. S. Nat. Mus., vol. 46, pp. 551–555.

[4] Ann. Mag. Nat. Hist., vol. 17, pp. 519–522, figs. 4–7.

[5] Zool. Jahrb., 1902, p. 146, fig. 89.

Dimensions	1	2	3	4
Length	3.75	3.92	5.03	6.10
Breadth of oral sucker	.35	.35	.36	.42
Breadth of pharynx	.13	.13	.18	.22
Breadth of ventral sucker	.80	.80	.91	1.36
Length of right testis	.32	.42	1.00	.53
Breadth of right testis	.38	.28	.77	.56
Length of left testis	.33	.40	.98	.53
Breadth of left testic	.40	.33	.88	.47

GALACTOSOMUM COCHLEARIFORME (Rudolphi)

Figure 52

1819. *Distoma cochleariforme* RUDOLPHI, Entoz. Syn., pp. 681–682.

1902. *Microlistrum cochleariforme* (Rudolphi) BRAUN, Zool. Jahrb. Syst., vol. 16, p. 56.

1911. *Galactostomum cochleariforme* (Rudolphi) PRATT, Zool. Anz., vol. 38, pp. 143–148.

The immature trematode here described was collected from the intestine of a man-o-war bird (*Fregata magnificens*), at Bird Key, Tortugas, July 8, 1907, by Dr. J. B. Watson.

Dimensions in balsam: Length 2.3 mm.; breadth, at oral sucker 0.42, at middle of neck, maximum, 0.70, at genital sucker 0.49, at posterior third 0.51; oral sucker, length 0.15, breadth 0.19; genital sucker, length 0.08, breadth 0.08; pharynx, length 0.11, breadth 0.08.

The muscular neck is broader than the body and appears to be itself an organ of adhesion. The pharynx is pyriform. There is no esophagus, and the intestinal rami extend to the posterior end. The cirrus-pouch is dorsal and at the right of the genital sucker. Behind it, and probably continuous with it, is the relatively large and muscular seminal vesicle. Their exact relation is not clearly shown in the mounted specimen. The lobed testes lie on the median line, one behind the other, and separated from each other by a space about equal to the longer diameter of a testis. They are nearly equal, and about 0.13 in length and 0.17 in breadth. The small, nearly round ovary lies a short distance back of the seminal vesicle and a little to the right of the median line. Its length is about 0.07 and its breadth about 0.08. The vitellaria are lateral, between the rami of the intestine and the margins, and extend from near the posterior end forward to a point on a level with the ovary on the left side, and about to the seminal vesicle on the right side. The uterus is not shown plainly in the mounted specimen. It could be seen indistinctly, however. A diagrammatic representation of its apparent course is shown in Figure 52. Ova had not yet made their appearance. (Cat. No. 7943, U.S.N.M.)

MINUTHORCHIS, new genus

(Μινυθω, to diminish)

Body oval, thickish; oral sucker terminal; ventral sucker weak, close to oral sucker; pharynx adjacent to oral sucker; no esophagus; intestinal rami extend to posterior end of body. Testes near the lateral margins, transversely placed, and in the posterior half of the body; ovary behind testes, near the median line; vitellaria marginal; uterus voluminous, filling the interior of the body from the ovary to the genital pore, which is at the posterior edge of the oral sucker.

Genotype.—*Minuthorchis sanguineus*, new species.

MINUTHORCHIS SANGUINEUS, new species

Figures 53–56

This genus and species is based on a single distome found in the intestine of a laughing gull (*Larus atricilla*), July 18, 1911.

The living worm was oval in outline, thickish, upper surface firm, lower surface soft and yielding. The color was blood-red. The dorsal surface was covered with minute papillae. The papillae on the anterior portion of the body are pointed, posteriorly they are blunt. They are not distinguishable in the mounted specimen. With but the slight pressure of the cover-glass to affect the dimensions the length was 7 mm., the breadth 5. At first only one sucker, the anterior, was seen. Later the ventral sucker was distinguished. It lies close to, and is of about the same size as the oral sucker. The uterus was very conspicuous, its voluminous folds ventral, and extending from the posterior to the anterior end. The ova in the posterior folds were yellow, becoming increasingly darker anteriorly, those at the anterior end being dark brown. In the living worm the ova appeared to be long-elliptical, and about 0.11 by 0.04 in the two principal diameters.

Dimensions in balsam: Length 8.8 mm.; breadth 5.6; oral sucker, length, edge view, 0.24, breadth 0.46; ventral sucker, length 0.36, breadth 0.45; pharynx, length 0.24, breadth 0.18. Most of the ova are collapsed, and therefore much narrower than uncollapsed ones, the shorter diameter being less than half the longer. An uncollapsed ovum measured 0.088 by 0.047, and another 0.090 by 0.045 in the two principal diameters.

The mouth is directed anteriorly; the pharynx is pyriform with the smaller end anterior. In the mounted specimen the anterior half of the pharynx is embraced by the oral sucker. The ventral sucker is separated from the oral sucker by a distance approximating its own shorter diameter. It is elliptical in outline, the longer diameter transverse, with weak musculature. The intestinal rami

take their origin directly from the pharnyx, are relatively slender, and extend to near the posterior end of the body. The genital pore is at the posterior border of the pharynx. The seminal vesicle is oval-elliptical, 0.31 by 0.15, its longer diameter transverse to the body. It lies on the left side with its inner end on the median line. It has muscular walls and is filled with spermatozoa. No cirrus was seen. The two relatively small testes are nearly symmetrically placed at about the posterior fourth, opposite, and about 2.8 mm. from each other. The right testis is 0.52 in diameter, and 0.7 from the right lateral margin; the left is 0.38 in diameter, and 0.56 from the left lateral margin. The right testis is about 2.38, and the left about 2.45 from the posterior end. Ovary, length 0.46, breadth 0.56, is on the median line, behind the testes, and 1.68 from the posterior end. The vitellaria are lateral, beginning about 1.4 from the anterior end, and are distributed along the lateral margins in clusters which approach a rosette-like structure.

Anteriorly these clusters form a single series, but in the posterior half of the body they lie in a double series. The uterus, filled with ova, occupies all the interior of the body from the ovary to the oral sucker. It is tubular, from 0.15 to 0.30 mm. in diameter, and lies in many irregular convoluted folds. The complex of genital ducts in the vicinity of the shell-gland is not clearly shown in the mounted specimen. The shell-gland lies at the antero-sinistral border of the ovary, the oviduct lying in many folds on the ventral side of its anterior border. A yolk duct, leading from the left marginal vitellaria to the posterior edge of the shell-gland was noted, and another from the right vitellaria was faintly indicated. These ducts led to a small yolk reservoir. No seminal receptacle was seen.

Type.—Cat. No. 7944, U.S.N.M.

DISTOMUM species

Two small distomes, belonging to different genera, from the intestine of the surf scoter (*Oidemia perspicillata*), are here noted. (Cat. No. 7945, U.S.N.M.)

A. Figure 57

This distome was collected July 12, 1913.

Dimensions, life: Length 0.32 mm.; breadth 0.17; diameter of oral sucker 0.033, of ventral sucker 0.048; ova 0.013 by 0.007.

Dimensions in balsam: Length 0.30; breadth 0.11; breadth of oral sucker 0.024, of pharynx 0.014, of ventral sucker 0.041; length of pharynx 0.027. Figure 57 is a sketch of this distome stained in haematoxylin and mounted in balsam. The anatomy is not shown satisfactorily. The ventral sucker is weak, and can be distinguished

only by careful focussing. It is a little in front of the middle, and larger than the oral sucker; pharynx adjacent to the oral sucker, longer than broad; esophagus about twice as long as the pharynx; intestinal rami traced as far as the testes, probably extend to the posterior end. The two testes are nearly transverse, a little nearer to the ventral sucker than to the posterior end. The cirrus-pouch is on the right of the ventral sucker, and the metraterm on the left; genital pore on the median line in front of the ventral sucker. The ovary is circular in outline and situated to the right of the median line in front of the right testis. A vitelline reservoir on the ventromedian border of the ovary, and a transverse yolk-duct, leading to it from the left side, and lying in front of the left testis were clearly shown. Vitellaria mainly marginal, from level of anterior border of testes to posterior end. The uterus contained but few ova, so distributed, however, as to indicate that it passes back between the testes to the posterior part of the body, and returning, passes along the left border of the ventral sucker to the genital pore.

B. Figure 58

After mounting the distome described under A, above, another small distome was found on the slide.

Dimensions in balsam: Length 0.24 mm.; breadth, at anterior end 0.09, at level of ventral sucker, maximum, 0.10; diameter of oral sucker 0.08, of ventral sucker 0.018; ova, maximum, 0.018 by 0.010.

Short, nearly linear, truncate in front, bluntly pointed at posterior end. Oral sucker nearly terminal, its diameter nearly equal to diameter of body. No muscular pharynx was seen, the oral sucker and the esophagus appearing to be funnel-like; ventral sucker much smaller than the oral, situated at about the posterior third. The intestinal rami begin near the middle of the body, and reach barely to the level of the ventral sucker. A conical structure on the ventral side of the bifurcation of the intestine has the appearance of being a diverticulum of the intestine. The genital pore was faintly indicated at the anterior border of the ventral sucker; testes two, at posterior end near lateral margins, nearly transverse; ovary ventral, and at anterior border of right testis. The vitelline gland is compact and close to the posterior border of the ventral sucker. Ova are widely distributed in the posterior half of the body. They lie along the lateral margins from the level of the anterior border of the testes to about the anterior third of the body. They also lie between the testes, and are scattered over the median region of the body both behind and in front of the ventral sucker.

ORNITHOBILHARZIA species

Figures 59–63

1912. ODHNER, Zoolog. Anzeig., vol. 41, p. 61.

From *Larus argentatus*, *L. philadelphia*, *Nycticorax nycticorax*, and *Oidemia deglandi.*

Although this distome is a blood parasite, all of the worms here considered appeared among material from the alimentary canals of their hosts. No search was made in the blood vessels or gall bladders, but in the process of removing and examining the viscera blood parasites might easily be liberated and appear in the washings from the alimentary canal.

In such characters as can be made out these worms from different specific hosts are in close agreement.

The female in all cases was enclosed in the gynaecophoric canal of the male. In most cases it was shorter than the male, but in one pair it appeared to be at least as long as the male. The oral and ventral suckers are rather prominent, nearly circular, near together, the ventral somewhat larger than the oral. There is no pharynx. The intestine, at first a single tube, bifurcates behind the ventral sucker, the two rami uniting toward the posterior end of the body. There is a tendency in the body of the male to coil helixwise. In the male the testes were indicated as many but they were not clearly defined. In the females only the vitellaria in the posterior part of the body could be distinguished.

On account of the unsatisfactory condition of the material specific allocation does not seem to be advisable.

Some additional details are given in the record of collections from the several hosts.

RECORD OF COLLECTIONS

Larus argentatus.

1912, February 16. 6 pairs; lengths 5 mm., more or less.

1913, February 12. 2 pairs, the males 3.5 and 9 mm. in length, respectively. The larger male was roughly tuberculate for a distance of about 2 mm., beginning 0.7 mm. back of the oral sucker. (Fig. 59.) (Cat. No. 7946, U.S.N.M.)

April 17. 1 pair; length of male 5.5 mm.

1915, February 18. 2 males.

The above collections were made by Vinal N. Edwards.

1920, December 18. 5 pairs. Collected by Robert A. Goffin.

Notes on specimens from the herring gull: Diameter of oral sucker of male, average of 8 specimens, 0.19 mm., of ventral sucker, average

of 8, 0.31; maximum, oral sucker 0.25, ventral sucker 0.35; minimum, oral sucker 0.17, ventral sucker 0.22; maximum length of male, 7 mm., minimum 3 mm.; diameter of oral sucker of a female 0.050, of ventral sucker 0.056. In one male, length 4.62; oral sucker, length 0.24, breadth 0.22; ventral sucker, length 0.32, breadth 0.31. In most cases the intestine contained dark brown material. In one male measuring 3.9 mm. in length the intestine divided at a point about 1.4 mm. from the anterior end, and the two rami united about 1.4 mm. from the posterior end.

Larus philadelphia.

1912, December 21. 5; lengths from 4.5 to 5 mm. The males are rather plump; one, 4 mm. in length, has a maximum diameter of 0.52; diameter, lateral view, of oral sucker 0.13, of ventral sucker 0.17. In one specimen, length about 3.2 mm., the bifurcation of the intestine is about 0.77 from the anterior end, and the rami unite about 1.26 from the posterior end. The cuticle is missing from all, longitudinal muscle fibers appearing in the superficial layer. (Cat. No. 7947, U.S.N.M.)

Nycticorax nycticorax naevius.

1913, July 3. 1 pair. These were rather fragile, and in the process of examination the female was lost. Length of male, in balsam, 3.36 mm.; diameter of oral sucker about 0.10, of ventral sucker, very indistinct, about 0.11.

Oidemia deglandi.

1913, August 14. 1, male, length 5 mm.; maximum diameter 0.45; diameter of oral sucker 0.17, ventral sucker 0.21; distance of anterior edge of ventral sucker from anterior end 0.46. This specimen, in balsam, measures 4.2 mm. in length. The point of bifurcation of the intestine appears to be about 1.4 from the anterior end, and the point at which the rami unite, about 1.2 from the posterior end. (Cat. No. 7948, U.S.N.M.)

PROALARIA INDISTINCTA (Guberlet)

Figures 64, 65

1922. *Hemistomum confusum* GUBERLET, Journ. Parasit., vol. 9, pp. 11–12, figs. 4–9.
1923. *Alaria indistincta* (Guberlet), GUBERLET, Trans. Amer. Mic. Soc., vol. 41, p. 68.
1926. *Proalaria indistincta* (Guberlet), LARUE, Trans. Amer. Mic. Soc., vol. 45, p. 15.

Larus delawarensis, intestine.

Woods Hole, Mass.: *Larus argentatus*, *L. atricilla*.

The following description is based on the specimen from *L. atricilla*.

Dimensions, life: Length 1.30 mm.; anterior portion, length 0.60, breadth, 0.60; posterior portion, length 0.70, diameter 0.40.

Dimensions in balsam, compressed, and margins of anterior portion folded: Length 1.22 mm.; anterior portion, length 0.56, breadth 0.36; posterior portion, length 0.66, breadth 0.38; pharynx, length 0.045, breadth 0.036; oral sucker, length 0.054, breadth 0.051; ventral sucker, length 0.058, breadth 0.075; diameter of adhesive organ 0.15; ovum 0.092 by 0.061.

Anterior portion of body broader and slightly shorter than posterior portion; oral sucker and pharynx each longer than broad, ventral sucker broader than long; pharynx adjacent to oral sucker; accessory adhesive organ close to posterior border of ventral sucker. Two conspicuous organs, one on either side of the oral sucker, 0.045 by 0.072 mm. in the two principal diameters, have a rasplike appearance under high magnification. Each is crossed by about 12 transverse ridges. Upon focussing up and down, these structures appear to be the roughened edges of a series of plates set on edge and close together.

The rami of the intestine originate very close to the pharynx and extend to the posterior end of the body. The two testes lie on the left side, the anterior one near the middle and the posterior one at about the posterior third of the posterior division of the body. They are separated by a fold of the uterus. The ovary lies on the left side at the anterior border of the first testis. The vitellaria extend throughout the entire length of the posterior division of the body, and as far forward as the posterior border of the ventral sucker, and obscure the other structures to a great degree. The ova are relatively large, not numerous, and mainly on the right side, from the posterior edge of the accessory adhesive organ to the posterior end. A few lie between the testes. The dense vitelline glands make it difficult to see details of the anatomy. The genital pore is dorsal, about 0.06 mm. from the posterior end.

RECORD OF COLLECTIONS

Larus argentatus.
1927, August 13. 2, lengths 1.40 and 1.70 mm.
L. atricilla.
1913, August 15. 1, length 1.30 mm. (Cat. No. 7949, U.S.N.M.)

ALARIA species

Figures 66, 67

A single, somewhat damaged specimen from the intestine of a ring-billed gull (*Larus delawarensis*), January 24, 1914, is here noted.

The oral sucker and pharynx are missing, and the specimen is broken at the level of the anterior border of the accessory adhesive organ.

Dimensions, balsam: Length 2.17 mm.; anterior division, length 1.40, breadth 0.42; posterior division, length 0.77, breadth 0.42; diameter of ventral sucker 0.06; adhesive organ, length 0.17, breadth 0.10. The bursa is everted, length 0.14, breadth 0.22; cirrus exserted, length 0.14, diameter 0.05.

Ova have not yet made their appearance. The anatomy is not satisfactorily shown in the mounted specimen. Vitellaria extend from about the middle of the posterior division forward to the ventral sucker, and mask the anterior testis and ovary. (Cat. No. 7950, U.S.N.M.)

This distome suggests *Hemistomum gavium* (Guberlet).[6]

STRIGEA BURSIGERA (Brandes)

Figures 68–72

1890. *Holostomum bursigerum* G. BRANDES, Zool. Jahrb., vol. 5, p. 592, figs. 15–18.
1909. *Strigea bursigera* (Brandes) LÜHE, Parasitische Plattwurmer. I. Trematodes, Brauer's Suswasserfauna Deuchlands, Heft 17, p. 163.

Larus ridibundus.

Woods Hole, Mass., *Larus argentatus*, *L. atricilla*, *L. delawarensis*, intestine.

Length from 6 to 9 mm.; anterior division of the body more or less pyriform, posterior division subcylindrical, enlarging slightly to the posterior third, where the greatest diameter is attained in the vicinity of the testes. The anterior end is usually reflected dorsally. There are some variations from the above proportions, but they can usually be accounted for by different conditions of contraction. Oral sucker, pharynx, and ventral sucker all small, the ventral a little larger than the oral. The two testes are lobed and situated behind the middle

[6] Journ. Parasit., vol. 9, pp. 9–11, figs. 10–13.

of the posterior division of the body, one following the other, but separated by a space in which lie the transverse yolk reservoir, the shell gland and oötype, and the beginning of the uterus. The ovary is situated close to the anterior border of the first testis. As seen in lateral view it is long-oval, the transverse diameter greater than the longitudinal, tapering at the median end, thus becoming somewhat pyriform. In a specimen from the laughing gull, mounted in balsam, the longer diameter is 0.28, shorter diameter 0.15. The first testis in this specimen had a maximum breadth of 0.45 and length of 0.24; second testis, breadth 0.59, length 0.36; distance of second testis from posterior end 1.40, or approximately one-fourth the entire length. In whole mounts of specimens from the ring-billed gull the ovary had the same dimensions as those given above; first testis, length 0.56, breadth 0.70; second testis, length 0.49, breadth 0.70; distance of second testis from posterior end approximately one-fifth the entire length in each. Behind the second testis there is a capacious seminal vesicle and a contorted, thick-walled ejaculatory duct. The copulatory bursa was invaginated in all cases. It is fairly well developed, as shown in Figure 71, which is somewhat diagrammatic, and occupies about one-half the distance between the second testis and the posterior end. The vitellaria are distributed mainly on the ventral side from near the constriction between the two divisions of the body to near the posterior end. In the specimens from the ring-billed gull and herring gull they were strongly developed, so much so as to mask much of the anatomy. The yolk reservoir is tubular. It originates on the ventral side and lies along the anterior border of the second testis. There is much variation in the number of ova. For example, in the specimen from the laughing gull there are relatively few ova, about 29, while two from the ring-billed gull contain the one 133 and the other 220, and one from the herring gull contains about 375. In one of the three series of sections the ova are few, in the others there are many. There is not much difference in the size of ova in the different examples. In the balsam mounts they do not vary much from 0.11 by 0.07 in the two principal diameters. The course followed by the uterus is in all cases from its origin between the testes forward towards the anterior end of the posterior division of the body, whence it returns on the ventral side to the posterior end. There is no seminal receptacle, but the early folds of the uterus were seen, in some of the series of sections, to be filled with sperm. In one series of sections the germ duct throughout its somewhat tortuous course, from near the ovary to the shell gland, as well as the earlier folds of the uterus, was filled with sperm.

Laurer's canal opens on the dorsal surface about on a level with the anterior border of the first testis. It is a small, somewhat con-

torted duct, and proceeds antero-ventrad to the postero-dorsal border of the ovary, where it turns caudad, and appears to join the germ duct. The germ duct lies along the dorsal side of the first testis. It enters the shell gland, where, near the middle of the intertesticular space, it becomes the rather thick-walled oötype. The short duct from the yolk reservoir joins it just before it expands into the oötype. The shell gland is relatively large and lies on the left side of the intertesticular space. Beyond the oötype the uterus is at first rather thick-walled and contracted. It then enlarges, becomes thin-walled, and lies in a number of folds between the testes on the right side. These folds were, in most cases, filled with sperm. The uterus passes along the ventral side of the first testis and continues forward to a point near the constriction between the two divisions of the body, where it turns abruptly, and, returning to the posterior end of the body, opens into the ejaculatory duct near the genital pore.

RECORD OF COLLECTIONS

Larus argentatus.

1915, September 1. 1; length 6.5 mm.; diameter, anterior division of body 1.35, posterior 1; anterior portion orange color, posterior yellowish. (Cat. No. 7951, U.S.N.M.)

1916, January 8. 3; length of longest about 6 mm.; diameter 0.75; anterior yellowish, posterior dark bluish-grey. Dimensions, balsam: Length 9.38 mm.; diameter, anterior 1.36, at level of testes 1.40; ova, longer diameter from 0.096 to 0.108, shorter diameter from 0.063 to 0.075, average 0.10 by 0.07. Measurements made from series of sagittal sections: Oral sucker 0.09; pharynx, length 0.075, breadth 0.09; ventral sucker, length 0.135, breadth 0.084; ova, average, 0.111 by 0.063.

Larus atricilla.

1911, July 19. 1; white, anterior portion tinged with orange. Dimensions, balsam, lateral view: Length 6.16 mm.; diameter, anterior, 0.65, at level of testes 0.77; oral sucker, length 0.090, breadth 0.075; pharynx, length 0.070, breadth 0.075; ventral sucker, length 0.112, breadth 0.089; ova, average of 6, 0.115 by 0.072. (Cat. No. 7952, U.S.N.M.)

Larus delawarensis.

1914, January 24. 3; lengths 8, 9, and 11 mm., in formalin. Dimensions, balsam: (1) Length 6.88; diameter, anterior 0.91, at level of testes 1.09; (2) Length 7.8; diameter, anterior 0.91, at level of testes 0.84; largest ova in each about 0.12 by 0.07. Measurements of sagittal sections: Diameter of oral sucker 0.081, pharynx 0.066; ventral sucker, length 0.114, breadth 0.075; ova, average, 0.114 by 0.072. (Cat. No. 7953, U.S.N.M.)

EXPLANATION OF PLATES

a. ventral sucker.
b. bursa.
c. cirrus.
cp. cirrus-pouch.
ej. ejaculatory duct.
ex. excretory vessel.
g. genital pore.
gd. germ duct.
h. holdfast organ.
i. intestine.
l. Laurer's canal.
m. metraterm.
o. ovary.
oe. esophagus.
ph. pharynx.
sg. shell gland.
sr. seminal receptacle.
sv. seminal vesicle.
t. testis.
u. uterus.
vd. vas deferens.
vg. vitelline gland.
yd. yolk duct.
yr. yolk reservoir.

Unless otherwise stated, sketches were made with the aid of the camera lucida from balsam mounts.

Plate 1

Haematotrephus fodiens, new species, from *Gavia immer*

Fig. 1. Ventral view of free individual; length 11 mm. The dark-brown, opaque material, which filled the intestine, is not represented in the sketch.
2. Anterior end of same, enlarged; length of pharynx 0.10 mm.
3. Worm from a pedicelled cyst on the serous coat of the pancreas.
4. Anterior end of same; length of pharynx 0.06 mm.
5. Portion of body of same in vicinity of genital pore; diameter 0.14 mm.
6. Posterior end of rami of intestine of same.

Plate 2

Psilostomum plicitum, new species, from *Larus argentatus*

Fig. 7. Ventral view; length 1.61 mm.

Psilostomum lineatum, new species, from *Larus argentatus*

8. Ventral view; length 3.78 mm.

Psilostomum varium, new species, from *Gavia immer*

9. Ventral view; length 1.54 mm.

Petasiger nitidus, new species, from *Colymbus auritus*

10. Ventral view; length 1.75 mm.

Plate 3

Petasiger nitidus, new species (continued)

Fig. 11. Ventral view of head, in glycerine; diameter, including spines, 0.49 mm. The recurved dorsal spines in this specimen seem to be exceptional.
12. Ventral view of another specimen; diameter, including spines, 0.42 mm.
13. Dorsal view of same.
14. Transverse section at level of ventral sucker; diameter 0.38 mm. *pr.* prostate gland.
15. Transverse section at level of ovary, diagrammatic.
16. Transverse section near posterior end; diameter 0.20 mm.

Himasthla elongata (Mehlis), from *Larus argentatus*

17. Ventral view; length 6.30 mm.
18. Ventral view of head in glycerine; diameter, including spines, 0.36 mm.
19. Postero-lateral spines, more highly magnified; length of spine 0.054 mm.
20. Female genitalia; diagrammatic, from transverse sections.

Plate 4

Himasthla incisa, new species, from *Oidemia deglandi*

Fig. 21. Ventral view; length 9 mm.
22. Anterior end of same; diameter at level of ventral sucker 0.6 mm.
23. Oral spines, foreshortened, sketched from a transverse section; Spencer 6x/4 mm.
24. Oral spines; longer spines 0.051 by 0.018, shorter 0.039 by 0.012 mm.
25. Transverse section near anterior border of ventral sucker; breadth 0.43 mm. The section in front of this contained the genital pore.
26. Transverse section at level of ovary; breadth 0.74 mm.
27. Transverse section immediately behind ovary; partly diagrammatic, about four consecutive sections used; breadth 0.8 mm.

Plate 5

Himasthla incisa, new species (continued)

Fig. 28. Transverse section at level of seminal vesicle; breadth 0.67 mm.
29. Transverse section near posterior end; breadth 0.38 mm.
30. Margin of body at anterior end of vitellaria; average length of serrations about 0.02 mm.
31. Margin of body at level of ovary; length of serrations about 0.04 mm.
32. Transverse section of body wall at level of seminal vesicle; Spencer 6x/4 mm.; *cg.* cuticular gland; *lm.* longitudinal muscle.
33. Transverse section of body wall at level of ovary; Spencer 6x/4 mm.

Mesorchis pseudechinatus (Olsson), from *Larus argentatus*

34. Ventral view of body, lateral of head and neck; length 5.32 mm.
35. Dorsal view of slightly macerated specimen, from which all spines had disappeared; length 4.48 mm.
36. Ventral view of body, dorsal of head and neck; length 3.5 mm.
37. Ventral view of head, in glycerine; diameter, including spines 0.42 mm.

PLATE 6

Mesorchis pseudoechinatus (Olsson) (continued)

FIG. 38. Dorsal view of head; diameter 0.32 mm., from *Larus argentatus.*
39. Dorsal view of median region of body; breadth 0.6 mm.
40. Sagittal section, median region; diameter of ventral sucker 0.22 mm.
41. Ventral view of specimen from *Colymbus holbölli;* length 2.56 mm.
42. Ventral view of specimen from *Gavia immer;* length 2.20 mm.

Aporchis rugosus, new species, from *Sterna paradisea*

43. Ventral view of anterior portion of specimen; diameter at ventral sucker 0.35 mm.
44. Posterior portion of same; diameter 0.77 mm. Uterus somewhat diagrammatic in this and the preceding figure.
45. Ventral view of anterior end; diameter at ventral sucker 0.35 mm. spines diagrammatic.

PLATE 7

Aporchis rugosus, new species (continued)

FIG. 46. Camera lucida sketch of surface of body back of cirrus-pouch; breadth 0.28 mm.
47. Lateral margin at level of seminal vesicle; length of spines 0.03 mm.
48. Lateral margin at level of testes; average length of serrations about 0.07 mm.
49. Ovum; sketched from an ovum lying isolated from others in the metraterm; dimensions, exclusive of filament, 0.08 by 0.03 mm.

Ascocotyle plana, new species, from *Butorides virescens*

50. Ventral view; length 0.67 mm.

Levinseniella adunca (Linton), from *Crocethia alba*

51. Memorandum sketch made at time of collecting; tests and vitellaria added from stained specimen; length 0.8 mm.

Galactosomum cochleariforme (Rudolphi), from *Fregata magnificens*

52. Ventral view, uterus diagrammatic. length 2.3 mm.

PLATE 8

Minuthorchis sanguineus, new genus, and new species, from *Larus artricilla*

FIG. 53. Ventral view, uterus somewhat diagrammatic; length 8.8 mm.
54. Anterior end of same; transverse diameter of oral sucker 0.46 mm.
55. Ventral view of ovary, etc., partly diagrammatic: ovary 0.56 by 0.44 mm.
56. Ova; longer diameter 0.09 mm.

Plate 9

Distomum species, from *Oidemia perspicillata*. (See A, p. 25.)

Fig. 57. Ventral view; length 0.30 mm.

Distomum species, from *Oidemia perspicillata*. (See B, p. 26.)

58. Ventral view; length 0.24 mm.

Ornithobilharzia species, from *Larus argentatus*

59. Anterior end of pair, neck of male contracted; diameter of male at ventral sucker 0.6 mm.
60. Anterior end of female, dorsal view; diameter of oral sucker 0.05 mm.
61. Fragment of male with female; maximum diameter of male 0.52 mm.
62. Dorsal view of male showing intestine; length 3.9 mm.

Plate 10

Ornithobilharzia species (continued)

Fig. 63. Lateral view of pair; length of male 3 mm.

Proalaria indistincta (Guberlet), from *Larus atricilla*

64. Sketch of specimen in alcohol, slightly compressed; length 1.33 mm.
65. Ventral view of mounted specimen; length 1.22 mm.
    b. Lateral organ.

Alaria species, from *Larus delawarensis*

66. Fragment, anterior, ventral view; length 1.05 mm.
67. Fragment, posterior; length 1.05 mm.

Plate 11

Strigea bursigera (Brandes)

Fig. 68. Lateral view of specimen from *Larus atricilla;* length 6.3 mm.
69. Ventral view of anterior end of specimen from *Larus delawarensis;* breadth 1 mm.
70. Sagittal section of anterior end of specimen from *Larus argentatus;* diameter 0.56 mm.
71. Sagittal section, posterior end, somewhat diagrammatic; diameter 0.56 mm.
72. Posterior end of mounted specimen; diameter 1.33 mm.

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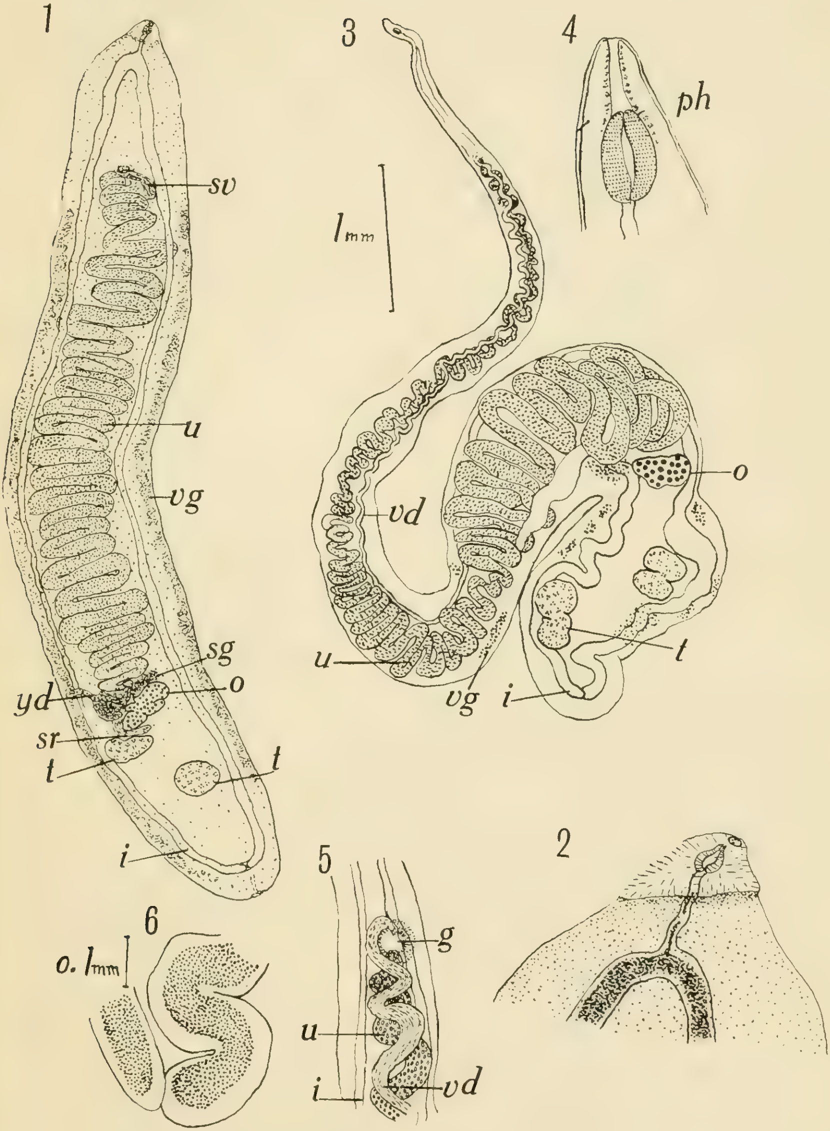

MONOSTOME TREMATODE OF THE LOON

FOR EXPLANATION OF PLATE SEE PAGE 33

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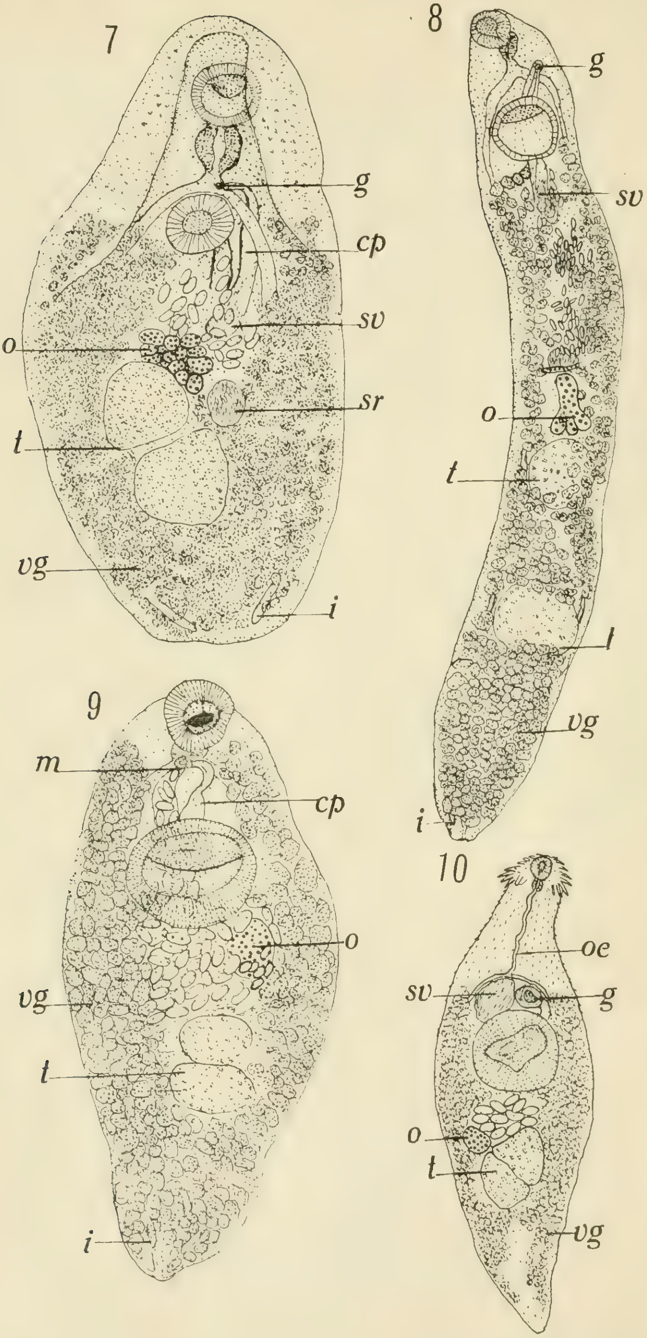

DISTOMES OF HERRING GULL. LAUGHING GULL, LOON, AND GREBE

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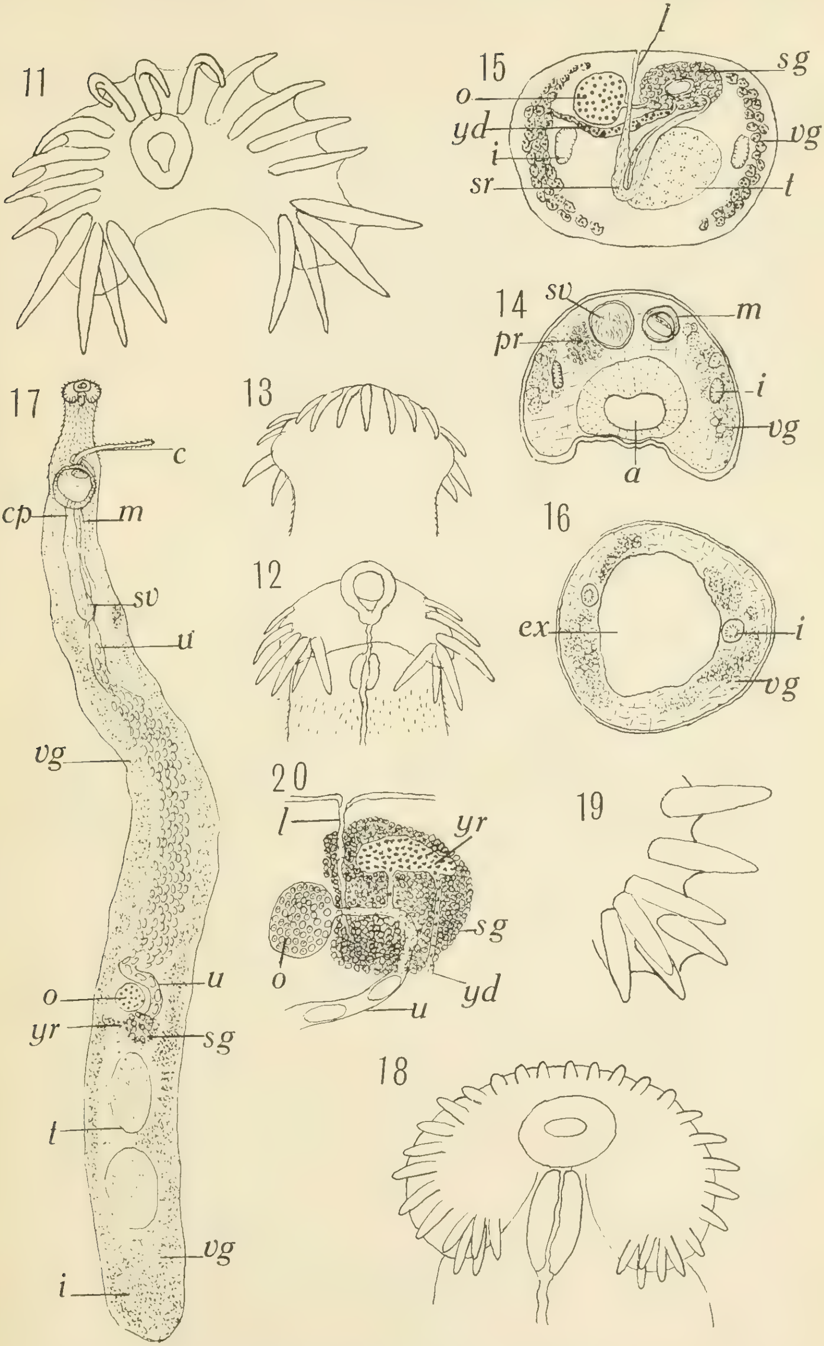

DISTOMES OF GREBE AND HERRING GULL

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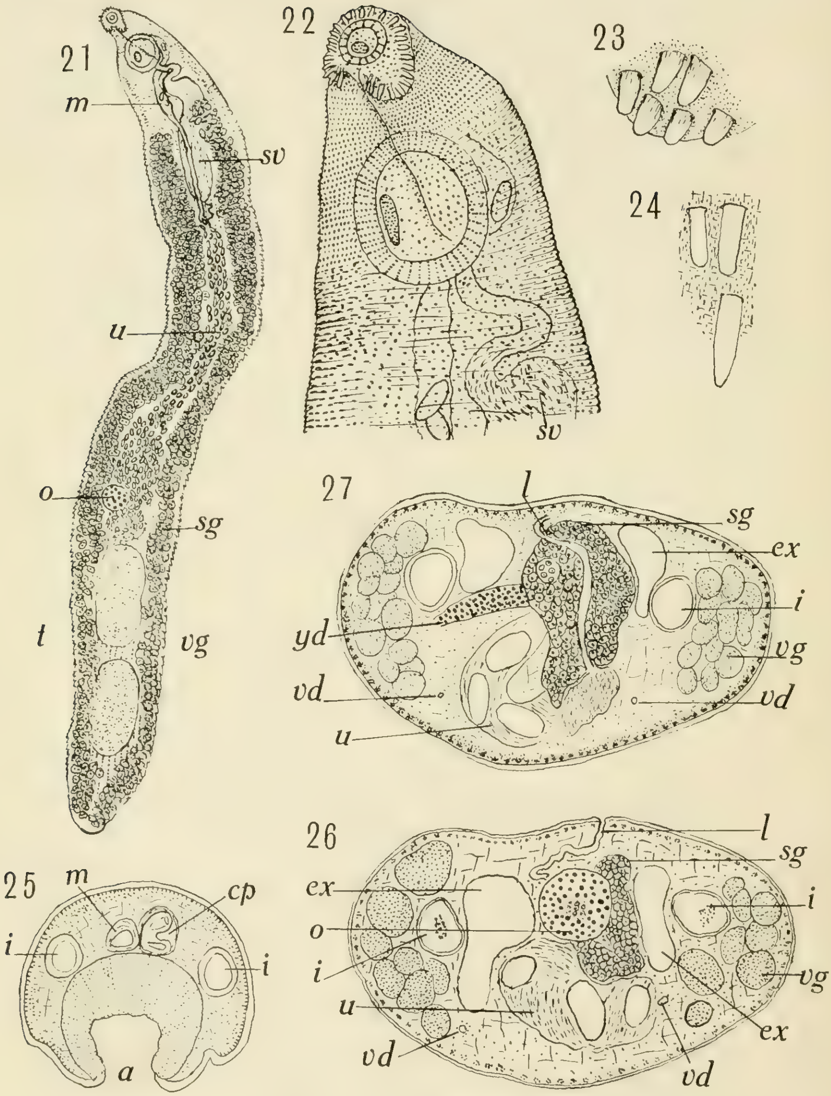

DISTOMES OF WHITE-WINGED SCOTER

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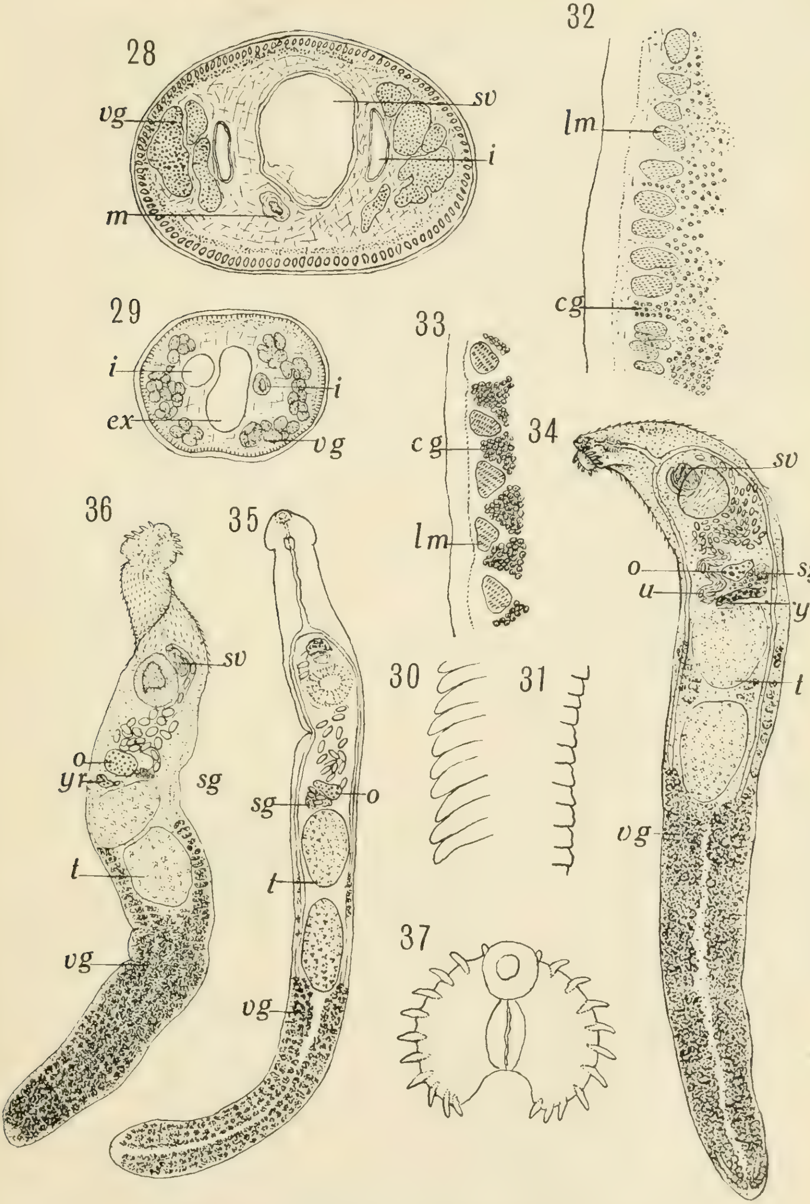

DISTOMES OF WHITE-WINGED SCOTER AND HERRING GULL

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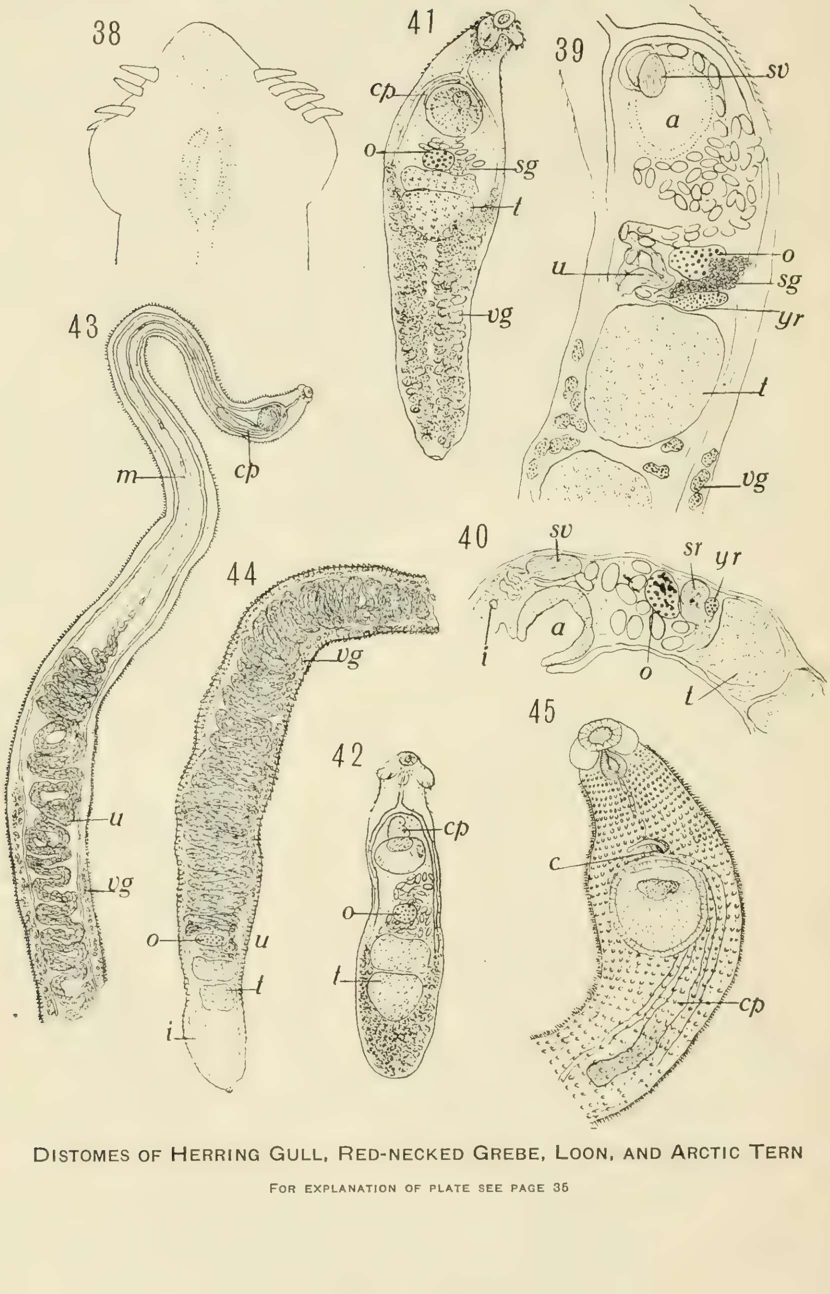

DISTOMES OF HERRING GULL, RED-NECKED GREBE, LOON, AND ARCTIC TERN

FOR EXPLANATION OF PLATE SEE PAGE 35

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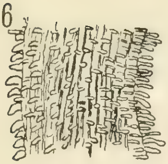

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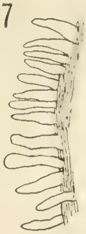

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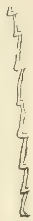

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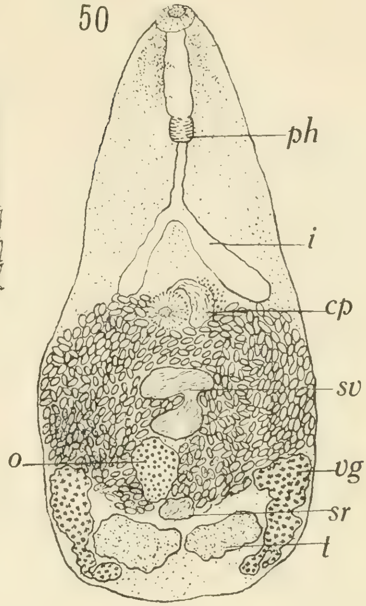

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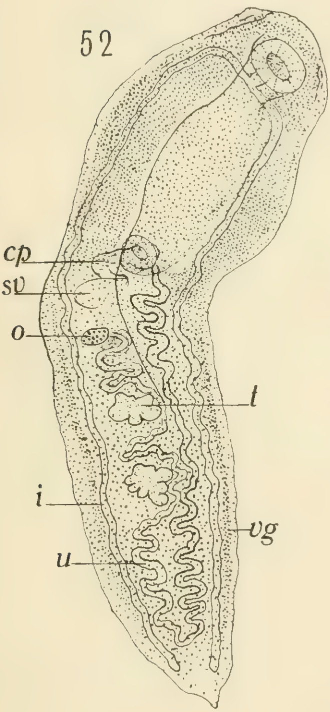

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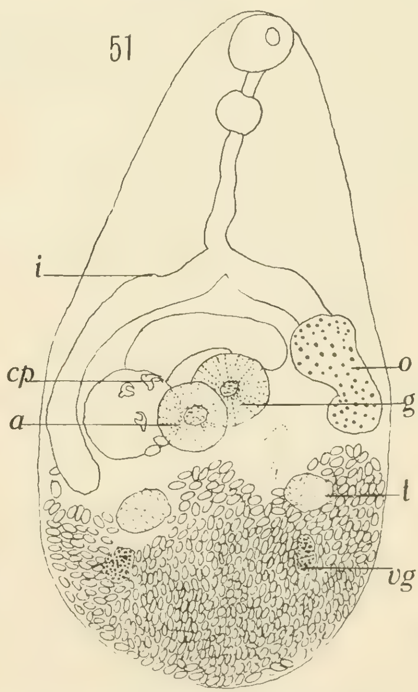

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DISTOMES OF ARCTIC TERN, GREEN HERON, SANDERLING, AND FRIGATE BIRD

FOR EXPLANATION OF PLATE SEE PAGE 35

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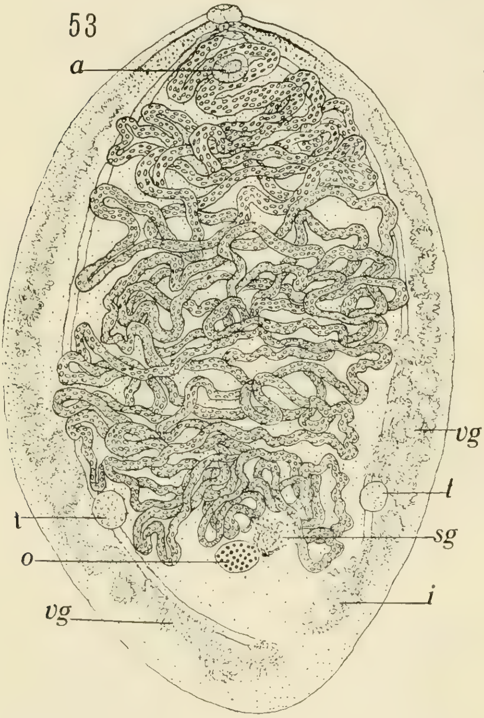

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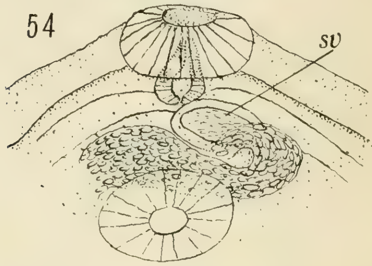

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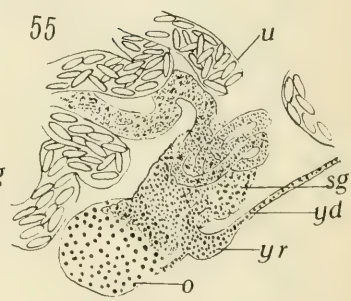

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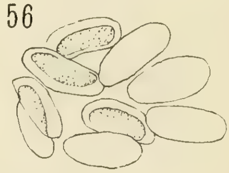
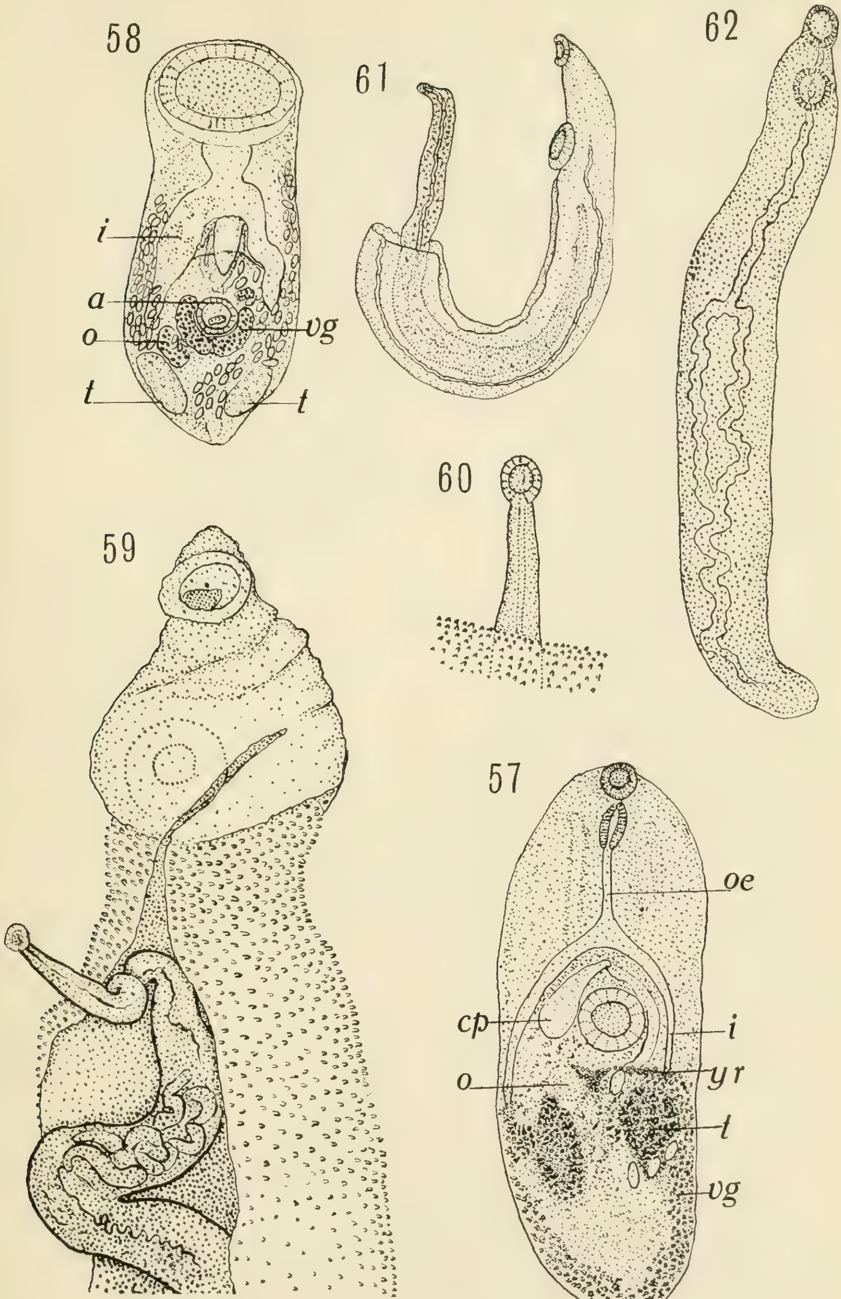


DISTOME OF LAUGHING GULL

FOR EXPLANATION OF PLATE SEE PAGE 35



Distomes of Surf Duck and Herring Gull

For explanation of plate see page 36

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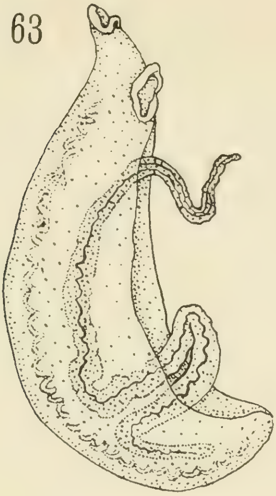

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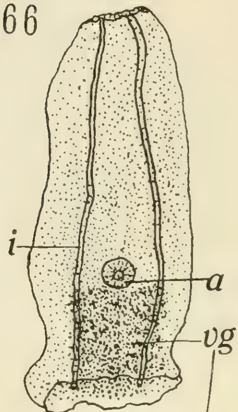

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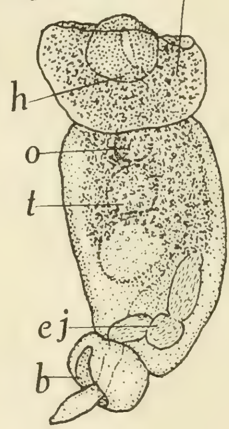

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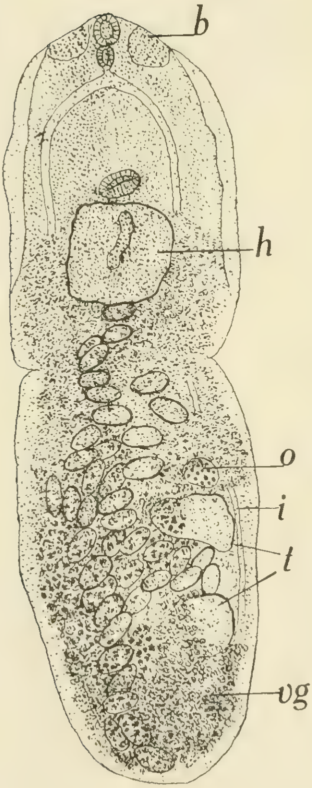

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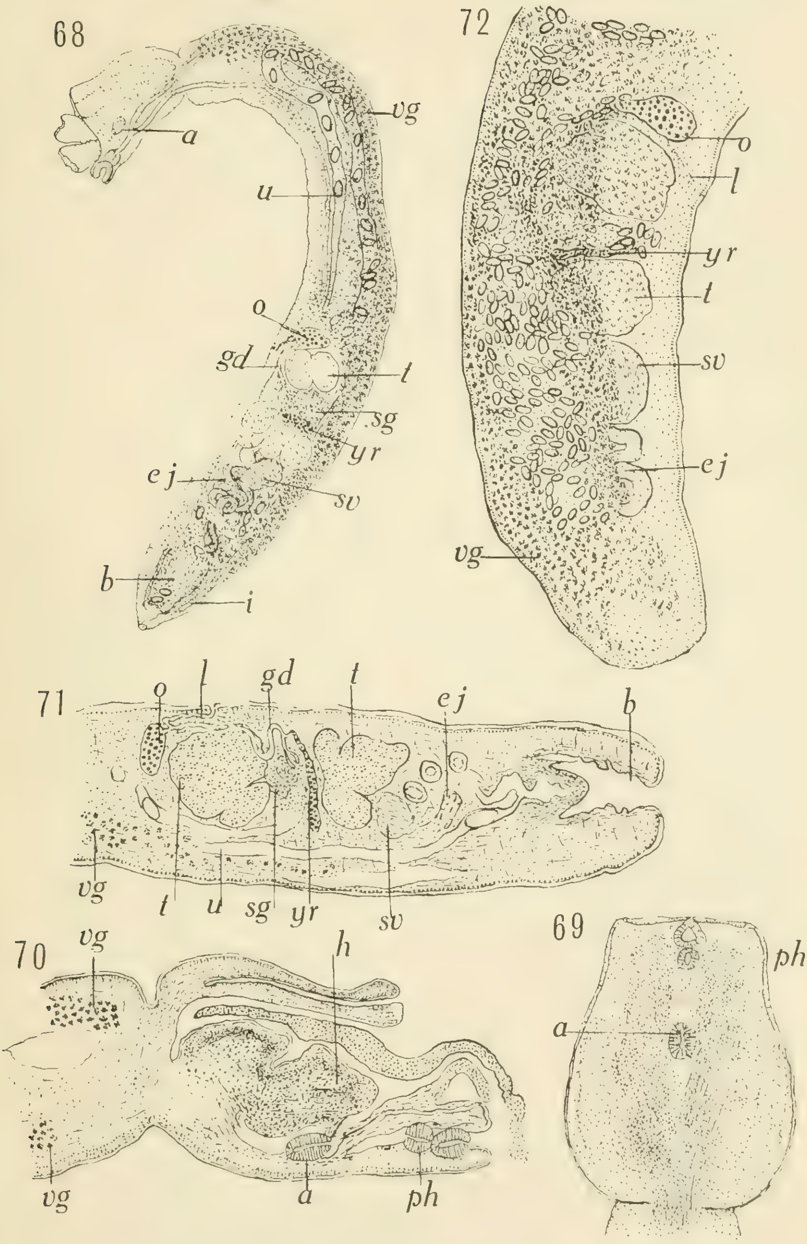
Distomes of Herring Gull, Laughing Gull, and Ring-billed Gull

For explanation of plate see page 36



DISTOMES OF LAUGHING GULL, RING-BILLED GULL, AND HERRING GULL

FOR EXPLANATION OF PLATE SEE PAGE 36

TWO NEW NEMATODES OF THE FAMILY STRONGYLIDAE, PARASITIC IN THE INTESTINES OF MAMMALS

By Benjamin Schwartz
Zoologist, Bureau of Animal Industry

The first parasite described in this paper was collected by Dr. E. W. Price, of the Bureau of Animal Industry, in the course of a post-mortem examination of a wart hog (*Phacochoerus aethiopicus massaieus*) which was received at the National Zoological Park, Washington, D. C., on October 26, 1926, and which died June 6, 1927. The worms, which represent a new genus and species, were found in the large intestine in association with three species of the nematode genus *Oesophagostomum* as follows: *O. mwanzae*, *O. eurycephalum*, and *O. yorkei.*

PHACOCHOEROSTRONGYLUS, new genus

Strongylidae.—The mouth is directed straight forward. There are four submedian and two lateral cephalic papillae. An external and an internal leaf crown are present. The buccal capsule is rather shallow and cylindrical in shape. The esophagus is club-shaped. Male bursa with two lateral lobes and a well-developed dorsal lobe. Ventro-ventral and latero-ventral rays short, parallel, and close together; externo-lateral, medio-lateral, and postero-lateral rays originate from a common trunk, the last two being parallel and close together, the externo-lateral ray diverging from them. Externo-dorsal and dorsal rays arise from a common trunk. Dorsal ray with a pair of branches anterior to its cleft. Each of the terminal branches of the dorsal ray with one small or rudimentary accessory branch. Spicules slender, filiform, and sheathed. Gubernaculum present. Vulva and anus very close together. The terminal portion of the female bent dorsad. Vagina relatively long, communicating on each side with an ovejector, the ovejectors and uteri being parallel.

PHACOCHOEROSTRONGYLUS PRICEI, new species

The head (fig. 1) is separated from the rest of the body by a well defined transverse constriction. The buccal capsule is supported by chitinous walls whose appearance in optical section is shown in Figure 1. The external leaf crown consists of 10 elements which are long and pointed; the internal leaf crown consists of about 24

small elements. The first part of the esophagus consists of a broad anterior portion and a narrow posterior portion the latter gradually widening out to form the posterior part of the esophagus. The nerve ring is located approximately at the beginning of the second third of the esophagus in the region of the constricted portion of that organ. The cervical papillae are located slightly posterior to the middle of the esophagus. The lining of the walls of the esophageal funnel is modified to form six toothlike structures, triangular in shape with apex directed forwards.

Male.—The male is from about 8.5 to 10 mm. long by from 370 to slightly over 400μ in maximum width and from about 185μ to 200μ wide just anterior to the bursa, in the region of the pre-bursal papillae. The head is from 117μ to 125μ in maximum diameter. The maximum width of the buccal capsule is about 100μ. The esophagus is from 756μ to 840μ long by 202μ in maximum width and 84μ in minimum width. The nerve ring is located at a distance of about 270μ from the anterior extremity of the esophagus, and the cervical papillae are located approximately in the middle region of the esophagus. The ventro-ventral and latero-ventral rays (fig. 6) have a horizontal direction and extend to the margin of the lateral lobes of the bursa. The medio-lateral and postero-lateral rays extend close to the margin of the bursa, whereas the externo-lateral ray which diverges from the former terminates at some distance from the margin of the bursa. The externo-dorsal ray arises at a distance of from 220μ to 250μ from the tips of the terminal branches of the dorsal ray. The undivided portion of the dorsal ray has a pair of accessory branches located at a distance of about 50μ from the point at which this ray becomes cleft; the accessory branches arise symmetrically (fig. 2) or asymmetrically (fig. 5) from the stem of the dorsal ray which is cleft on its posterior third, the diverging terminal branches being about 85μ long. Each terminal branch of the dorsal ray has a small accessory branch which may be rudimentary (fig. 5) and is located at a distance of about 33μ from the tip. The spicules (fig. 3) are slender, alate, from 672μ to 840μ long, and terminate in knoblike tips. The gubernaculum is more or less pear-shaped, from 63μ to 67μ long by about 21μ in maximum width.

Female.—The female is from 9 to 9.5 mm. long by 470μ to 487μ wide. The maximum diameter of the head is 134μ. Diameter of buccal capsule same as in male. The esophagus is from about 873μ to 923μ long by 235μ to 319μ in maximum width. In one specimen the nerve ring is located at a distance of about 285μ from the anterior extremity of the esophagus, being somewhat posterior to the beginning of the second third of that organ. In the same specimen the cervical papillae are located at a distance of 436μ from the anterior

end of the esophagus which is slightly posterior to the middle of that organ. The distance between the vulva and anus (fig. 7) is 67μ. The vagina is about 350μ long and each ovejector is about 285μ long or somewhat longer. The tail is 84μ long and terminates bluntly. The posterior end of the female is turned dorsad and has the appearance of a foot (fig. 4) when the worm is viewed from the side.

Host.—*Phacochoerus aethiopicus massaieus.*

Location.—Large intestine.

Locality.—National Zoological Park, Washington, D. C.

Type specimen.—No. 27789. U.S.N.M.

Paratypes.—No. 27790. U.S.N.M.

This species is named after Dr. E. W. Price who collected the nematode specimens from the wart hog and kindly turned them over to the writer for determination.

The second lot of specimens, which also represent a new genus and species, were collected by Dr. L. T. Giltner, of the Bureau of Animal Industry, from the intestine of a common wombat (*Phascolomys mitchelli*) about 10 years ago. The host animal in question was received at the National Zoological Park, Washington, D. C., on December 1, 1916, and died of pneumonia on July 8, 1917. Doctor Giltner made a post-mortem examination of the carcass and discovered a number of nematodes in the large intestine which he kindly turned over to the writer for determination. The illustrations accompanying the description of these worms (Plate 2) were made in July, 1917. Unfortunately most of the specimens were allowed to become dry at one time during the intervening period and it is therefore difficult to study the material at the present time in as great detail as is desirable. However, the salient characters of these nematodes indicate quite clearly that they represent a new genus and species.

OESOPHAGOSTOMOIDES, new genus

Strongylidae.—The mouth is directed straight forward. The mouth collar bears four prominent submedian and two lateral papillae. (Fig. 2.) The buccal capsule is of moderate depth and cylindrical in shape. (Fig. 5.) An external leaf crown is present; an internal leaf crown is absent. The esophagus is club-shaped. A ventral esophageal groove is absent. Male bursa with two lateral lobes and a well developed dorsal lobe. The ventro-ventral and latero-ventral rays are close together and parallel. The externo-lateral, medio-lateral and postero-lateral rays originate from a common trunk, the last two being close together and parallel the externo-lateral ray being separated from them by a relatively wide groove. Externo-dorsal and dorsal rays arise from a common trunk, the latter being cleft approximately in the posterior half, each terminal branch

with an accessory branch. The spicules are equal and alate; a gubernaculum is present. The vulva and anus are fairly close. The vagina is relatively long and is connected with two parallel ovejectors. The uteri are parallel.

The genus *Oesophagostomoides* is related to the genus *Oesophagostomum*, differing primarily from the latter in two important characters as follows: (1) Oesophagostomoides lacks a ventral cervical groove, which is a primary diagnostic characted of the genus *Oesophagostomum* and (2) the ovejector apparatus of *Oesophagostomoides*, which resembles that of the genus *Phacochoerostrongylus*, is a simpler structure than that of *Oesophagostomum*. In the latter each uterus opens posteriorly into an ovejector, the two ovejectors opening into a kidney shaped pars ejectrix which in turn communicates with the vagina. In the genus *Oesophagostomoides* the ovejector apparatus is relatively simple, the two ovejectors, which are continuous with the uteri, opening directly into the vagina.

The specific name *O. giltneri* is proposed for the species from *Phascolomys mitchelli* as an appreciation of Doctor Giltner's kindness in turning these specimens over to the writer for determination.

OESOPHAGOSTOMOIDES GILTNERI, new species

The cuticle behind the mouth collar is slightly inflated. The buccal capsule is as deep as or somewhat deeper than broad and is supported by chitinous walls the appearance of which in optical section is shown in Figure 5. The external leaf crown contains 8 elements. (Fig. 2.) The nerve ring is located anterior to the middle of the esophagus, and the cervical papillae are located posterior to the nerve ring, their position being variable. In two well preserved specimens a definite constriction of the cuticle in the esophageal region was observed, the position of the cuticular constriction corresponding approximately to the beginning of the second fourth of the esophagus. Whether this constriction is also present in other specimens could not be definitely determined owing to the condition of the specimens, many of which have a wrinkled cuticle as a result of having become dry at one time.

Male.—The male is from 10 to 11 mm. long by about 375μ in maximum width. The diameter of the mouth collar is 84μ. The esophagus is from 587μ to slightly over 630μ long by about 120μ in maximum width. The nerve ring is located approximately at the beginning of the third fifth of the esophagus. In a specimen in which the esophagus is about 630μ long the nerve ring is located at a distance of 264μ from the beginning of the esophagus. All the rays of the bursa (figs. 3 and 4) are gradually attenuated and terminate in pointed tips. With the exception of the externo-lateral and the

externo-dorsal rays, all the rays reach the margin of the bursa. The dorsal ray is cleft anterior to its middle, the two terminal branches being about 152μ long. Each terminal branch gives off an accessory branch slightly posterior to its point of origin from the main stem of the dorsal ray. The spicules are slender, alate, about 780μ long. The gubernaculum is more or less pear-shaped.

Female.—The female is from 12 to 15 mm. long by about 495μ in maximum width, some specimens being more slender. The esophagus is from about 620μ to 695μ long by 138μ to 144μ in maximum width. The nerve ring is located approximately at the beginning of the fifth ninth of the oesophagus. The vulva (fig. 1) has prominent lips and is located at a distance of 190 to 228μ from the anus. The vagina is about 230μ long. The ovejectors are about 265μ long. The tail is from 90μ to 105μ long, its terminal portion being slender and blunt.

Host.—Common wombat (*Phascolomys mitchelli*).

Location.—Large intestine.

Locality.—National Zoological Park, Washington, D. C.

Type specimens.—No. 27198, U.S.N.M.

Paratypes.—No. 19180, U.S.N.M.

EXPLANATION OF PLATES

a., anus; *c. p.* cervical papillae; *d.*, dorsal ray; *e. d.*, externo-dorsal ray; *e. l.*, externo-lateral ray; *g.*, gubernaculum; *int.*, intestine; *l. c.*, leaf crown element; *l. p.*, lateral-papilla; *l. v.*, latero-ventral ray; *m. l.*, medio-lateral ray; *n. r.* nerve ring; *oes.*, esophagus; *ovj.*, ovejector; *p. l.* postero-lateral ray; *sp.*, spicule; *s. p.*, submedian papilla; *t. d.*, terminal branch of dorsal ray., *ut.*, uterus; *vg.*, vagina; *v.* and *vl.*, vulva; *v. v.*, ventro-ventral ray.

PLATE 1

Phacochoerostrongylus pricei, new genus and species. Fig. 1, anterior portion of body; Fig. 2, externo-dorsal and dorsal ray; Fig. 3, posterior portion of male; Fig. 4, posterior portion of female (lateral view); Fig. 5, externo-dorsal and dorsal rays; Fig. 6, male bursa; Fig. 7, posterior portion of female.

PLATE 2

Oesophagostomoides giltneri, new genus and species. Fig. 1, posterior portion of female; Fig. 2, top view of head; Fig. 3, posterior portion of male (ventral view); Fig. 4, posterior portion of male (lateral view); Fig. 5, anterior portion of body.

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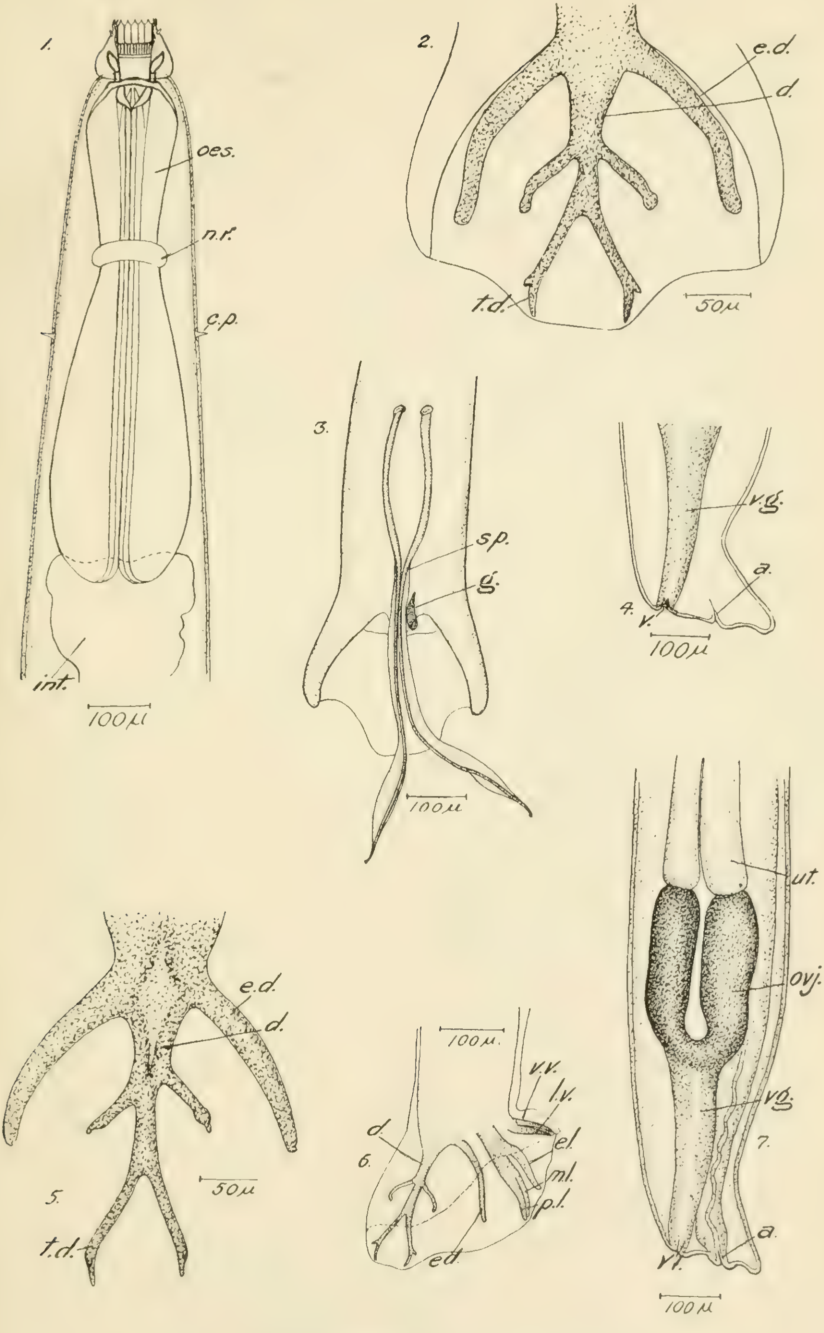
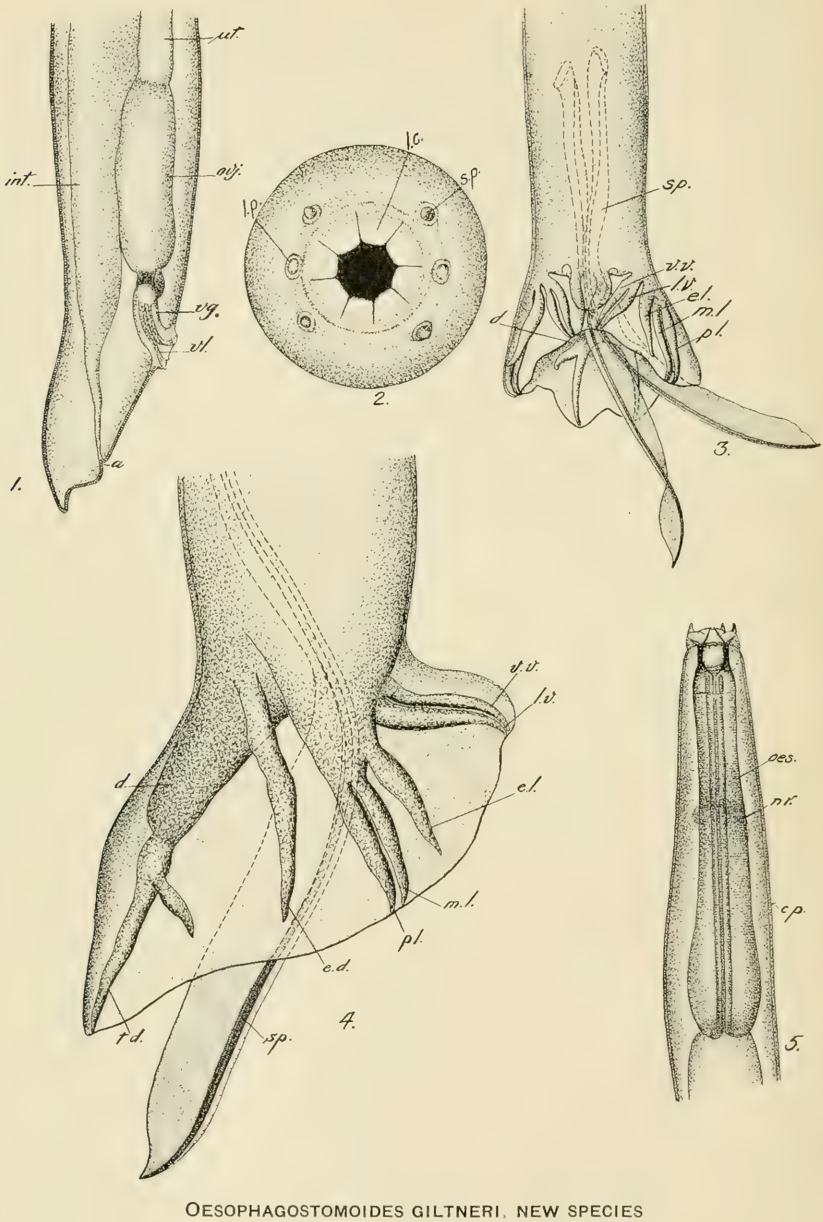


PHACOCHOEROSTRONGYLUS PRICEI, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 5



OESOPHAGOSTOMOIDES GILTNERI, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 5

FURTHER CONSIDERATION OF THE SHELL OF CHELYS AND OF THE CONSTITUTION OF THE ARMOR OF TURTLES IN GENERAL

By Oliver P. Hay

Associate of the Carnegie Institution of Washington

1. SUPERFICIAL, OR EPITHECAL, BONES

In 1922 the writer contributed an article to the *Journal of Morphology*[1] entitled "On the Phylogeny of the Testudinata and the relationships of *Dermochelys*." In this paper he called attention to the occurrence of certain plates of bone on the carapace and plastron of specimens of the South American pleurodire tortoise *Chelys*, known as the matamata. Some of the specimens studied belong to the American Museum of Natural History, New York; others are preserved in the United States National Museum. In the case of some of the shells there are many small bones irregularly distributed over the upper and the lower surfaces. The origin and nature of these were not determined. Other and usually larger bones occurred at definite points and were interpreted as relics of a primitive superficial armor retained nearly complete by the great sea turtle known as the leatherback, or *Dermochelys*. These bones were shown to occupy positions which correspond to 5 of the 12 keels which exist on the shell of *Dermochelys*, 7 on the carapace, 5 on the plastron.

After the publication of that article another matamata reached the United States National Museum from the Zoological Park at Washington and, inasmuch as this specimen presents many such bones, it is here described and illustrated by reproduced photographs. (Pls. 1 and 2.) From the front of the carapace to its rear the length is 13.5 inches (338 mm.). As in other specimens, there are on the carapace three prominent keels, a median and two lateral. The median keel presents five bosses or tuberosities, one at the rear of each vertebral scute. The hinder two are high and pointed. In each lateral keel are four such tuberosities, one at the upper rear corner of each costal scute. The marginal bones (peripherals) have each a projec-

[1] Vol. 26, pp. 421–445, with 2 pls.

tion or tuberosity of greater or less prominence; and these are placed along the sharp border of the carapace, one at the rear of each marginal scute.

From the carapace and plastron of the matamata here studied the scutes have been removed, and this has brought into view the superficial (epithecal) bones mentioned above. The epithecal bones of the plastron (not figured) occupy about the same positions as shown on plate 2 of the paper in the *Journal of Morphology;* but are more strongly developed. The one on the right gular scute spreads backward on the humeral scute. No such bone occurs on the hinder outer corner of the humeral scute areas of either the new specimen or of the ones previously described. From the front of each pectoral scute to the rear of the plastron there is a nearly continuous series of thin overlying bones. In the United States National Museum is a mounted skeleton of *Chelys* (Cat. No. 29545) whose epiplastron has along its whole lower border a rough surface which once supported an epithecal bone, where widest about 10 mm.

On the carapace (pl. 1) a minute ossicle is seen on the rear of the nuchal scute. On the boss situated about three-fourths of an inch in front of the hinder border of the first vertebral scute a scale of bone is to be expected. It is not present exactly there, but just a little in front of this there appears once to have been a narrow scale about 11 mm. long. Close to the rear of the second vertebral scute is a very distinct irregular ossicle, 10 mm. long and nearly as wide. Surmounting the tuberosity of the third scute is a bone about 12 mm. square forming an inset in the fifth neural bone. A smaller ossicle caps the fourth tuberosity. On the crest of the sharp ridge traversing the fifth vertebral scute area are several pits from which ossicles seem to have been torn away with the horny scute.

On the lateral keel of the left side the first, second, and third tuberosities support each a distinct bone, but there is none on the fourth. The same statement may be made about the tuberosities of the right lateral keel, but an ossicle on the third was evidently carried away on the horny scute.

On the left border of the carapace no epithecal bone appears on any of the first three tuberosities, but on the second scute, at the middle of the border, is a scale 10 by 15 mm. which may be looked upon as having migrated from the tuberosity just behind it. On the fourth tuberosity is a pit showing that a bone was torn away with the scute. On the left fifth scute area is a nearly circular bone 10 mm. in diameter, capping the boss. No superficial bone is seen on the sixth marginal scute. On the rear of the seventh scute area is a deep pit where a bone 20 mm. long was lodged; in fact, a part of it remains. On the rear of the eighth scute area is a scar or rough surface from which a superficial bone has been removed. Immediately

above this rough surface is a patch of superficial bone 10 mm. high and 5 mm. wide, and this is to be regarded as a part of the bone which occupied the scar. On the rear of the ninth scute area is a pitlike scar, 10 mm. long, which doubtless supported a nodule of bone. On the tenth, eleventh, and twelfth scute areas the apices of the toothlike projections of the marginal bones are rough and evidently were beset with minute ossicles.

On the right border of the carapace a rough sutural surface is seen on the fourth scute area, while on the front of the fifth area is an excavation which gives the impression that the bone of the fourth area was nearly 30 mm. long and overlapped on the fifth area. On the rear of the sixth area was a minute ossicle. A rough articular surface on the rear of the seventh scute area indicates the former presence of a bonelet 10 mm. long. A long splinter of bone, part of which remains, ran along the whole lower border of the eighth scute area, while on the rear of the ninth is a very distinct scale of bone 5 mm. in diameter. On the border of the tenth area is a rough articular surface, and a similar one is present on the eleventh. On the twelfth area, near the midline, is a scale of bone 22 mm. long, loose, and almost ready to drop out of its place.

2. RESULT SECURED BY DR. H. VÖLKER

In my paper of 1922 I endeavored to meet some of the arguments advanced by Doctor Versluys against my views regarding the position of *Dermochelys*. In so limiting myself I did not do justice to Dr. Heinrich Völker, who, under the direction of Doctor Versluys, investigated in a thorough manner the skeleton of the trunk, of the limbs, and of the skin. His results were published in 1913.[2] On his page 516, Doctor Völker accepts the view that on the dorsal and ventral sides of *Dermochelys* we must distinguish two layers of dermal bones, a superficial (epithecal) and a more deeply placed layer (thecal). To the epithecal, he concluded, belong the dorsal shield, or armor, and the ossifications of the five longitudinal keels of the ventral side. To the thecal layer belong the nuchal bone, perhaps vestiges of costal plates retained on the ribs, and the bones of the plastron. The earliest recognition of these two wholly distinct layers of bone, Völker says, is to be credited to the present writer. On his page 526 Völker wrote "Mit Hay und im Gegensatz zu Dollo (1901) nehme ich für die gemeinsamen Vorfahren von Atheken und Thecophoren den Besitz eines Doppelpanzers an."

On only one important matter, as regards the structure of the shell of the thecophorous turtles, does Doctor Völker differ from

[2] Spengel's Zool. Jahrbücher, Abt. Anat. Ontol., vol. 33, pp. 431–552, pls. 30–33 and 3 text-figs.

me. He insists that the peripheral bones are equivalent to the bones of the marginal keels of *Dermochelys* and belong, therefore, to the epithecal layer, while I have regarded them as belonging to the deeper layer. In my original paper[3] I could rely only on the relation of the marginal scutes to the underlying bones of tortoises in general and on certain bosses on the peripherals of *Toxochelys* to sustain my view. Now, however, that these epithecal bones have been discovered on the median and lateral keels of *Chelys* and on its peripherals, I do not see how Doctor Völker or anybody else can refuse to accept my identifications. It is evident that the thecophorous peripherals were not derived from the athecate marginals. With the acceptance of this view Doctor Völker would be relieved of his difficulty (his page 525) in explaining how it happens that the horny scutes do not coincide with the peripherals.

On his page 530, Völker concedes that the suprapygal bones belong to the thecal skeleton, in view of my discovery that these in *Toxochelys* were overlain by epithecal elements, but he insists that the pygal bone is an epithecal bone. As he says, "Neither *Dermochelys*, nor *Archelon*, nor *Protostega* offers a solution of the question." To this may be said that *Chelys* does offer the solution. This bone is covered by the rear ends of the twelfth marginal scutes. As told above, on the twelfth scute area of the right side is a large loose bone (pl. 2, fig. 1) 20 mm. long. A few millimeters above it is another small scale of bone. Near the upper left border of the pygal (same figure) is tightly embedded an epithecal scale.

In evaluating the affinity of *Dermochelys* with the Cheloniidae Doctor Völker places the supposed epithecal marginal bones in the balance in favor of a close relationship. If we accept his view the elements of the shells of the Thecophora and of the Athecae may be thus expressed (his page 530):

Thecophora		Athecae	
Thecal elements	Nuchal. Neurals. Costal plates. Plastral bones.	Thecal elements	Nuchal. Possible shreds of costal plates on the ribs. Plastrals.
Epithecal elements	Marginal bones. Pygal. Vestigial shreds on the keels of rare species.	Epithecal elements	Dermal armor, upper and lower. Marginal bones.

If now the marginal elements and the pygal of the Thecophora belong to the thecal layer, as shown above, the statement will stand thus:

[3] Amer. Naturalist, vol. 32, 1898, pp. 929–948.

	Thecophora		Athecae
Thecal elements	Nuchal. Neural plates. Costal plates. Marginal bones Suprapygals. Pygal. Plastrals.	Thecal elements	Nuchal. Vestigial shreds on costal plates. Plastrals, greatly reduced.
Epithecal elements	Vestigial ossicles on the keels of a few species.	Epithecal elements	Upper and lower dermal armor, including the ossicles of the marginal keels.

When we consider the fact that the thecal elements of the Athecae are nearly as much reduced as the epithecal of the Thecophora it must be admitted, I believe, that the two groups are pretty widely separated.

3. ORIGIN OF THE PERIPHERAL BONES

In my paper of 1922, on page 426, I suggested that the thecal peripherals of the Thecophora may have arisen from a series of bones at the outer ends of gastralia. At present I am inclined to look on them as a row of bones developed one at the distal end of each of the costal plates. The costal plates and these hypothetical peripherals would have the relative positions of the large dorsal and the small lateral plates seen in the figures of *Aëtosaurus*. The third peripheral may be regarded as belonging to the first costal plate, that overlying the second rib. The first rib is greatly reduced and no costal plate is developed in connection with it. Nevertheless, its distal plate may have bene retained as the second peripheral. Usually no neural plate is developed which corresponds to the first dorsal vertebra, but in some species of Trionychidae, as *Aspideretes gangeticus* (Cuvier), there is present a plate of bone, the praeneural which seems to belong with that vertebra. At present it appears to me that the nuchal bone may be a plate homologous with the neural plates and to have been in relation with the neural spine of the last less cervical. In some ancestor a cervical rib may have been overlain by a plate of bone, long ago absorbed; but an accessory plate at its distal end may have been preserved and have become the first thecal peripheral.

4. RELATION OF THE NUCHAL TO THE EIGHTH CERVICAL VERTEBRA

Much importance is attached to the connection between the nuchal plate and the neural spine of the eighth cervical in the leatherback and the other sea turtles. If the writer's suggestion is correct that the nuchal bone is a homologue of the dorsal neural plates the con-

nection mentioned above is a primitive one. In the great majority of tortoises this connection was lost, in order to facilitate the withdrawal of the head and neck into the shell or alongside of it. In the seafaring turtles the articulation may have been retained as a point of suspension for the head and neck.

5. SUBORDERS OF THE TESTUDINATA.

Tortoises must have existed already at some time during the Permian, for in the Triassic they appear with all their essential characters. In the Permian all the species may have belonged to one family, but differentiations had begun. There were yet probably none which could withdraw the head within the shell or hide it under the edge of the carapace. No definite cervical vertebrae yet existed, but in place of each a congeries of cartilaginous or bony basalia. Nevertheless there were tendencies which later revealed themselves in the normally bent neck of the Cryptodira and that peculiar to the Pleurodira.

Every chelonian is related to every other one of the order, but to some more closely than to others. I grant that *Dermochelys* is connected with the Cheloniidae more closely than with any other family of the order. In the undifferentiated condition of Permian days the ancestors of the Athecae and of the Cheloniidae may have been intimately related, but when the primal athecate broke away from the association, chose a life on the high seas, began to throw off the armor preferred by the others of his tribe and clothed himself with another, he won the right for his descendants to be regarded as a separate branch of the testudinate host.

Doctor Völker recognized the considerable differences existing between the Athecae and the other sea turtles, but he insisted that to regard the two as belonging to distinct suborders gave a very false conception of their kinship. He concluded (his page 512) that the relationship was best expressed by making *Dermochelys* and the other sea turtles a superfamily of the Cryptodira. If, however, this is done the other Cryptodira must constitute another superfamily and these two will form the suborder of Cryptodira. Then the Pleurodira and Trionychoidea must in their turn be given the rank of suborders. The writer believes that the Emydidae, Trionychidae, and the Chelyidae do not differ sufficiently from one another to be representations of as many suborders. Furthermore, Doctor Völker's scheme by no means brings out the great differences which have been demonstrated and which he concedes as existing between *Dermochelys* and the Cheloniidae. The writer maintains that the relationships between the groups of the Testudinata are best expressed by setting off the Athecae as a suborder opposed to the Thecophora.

6. RELATION OF THE COSTAL PLATES TO THE RIBS

In the carapace of the thecophorous chelonians the broad costal plates are intimately fused with the underlying ribs. If my explanation of the construction of the carapace is correct, those costal plates at some time in the history of these animals were free from the ribs; also it is probable, or at least possible, that in the embryologic development of some existing species the costal plates will be found to arise by distinct centers of ossification and only later to fuse with the ribs. Eminent naturalists have argued on this side of the question; others on that; a few, possibly, on both sides. Apparently Goette was the first to make a thorough investigation of the embryonic development, and he appeared to prove that the costal plate had in it no element of dermal bone. Nevertheless, Völker found himself driven to conclude that Goette was in error. A Japanese naturalist, Ogushi,[4] working on a species of soft-shelled tortoise (*Trionyx*), found that Goette's explanation compelled the conclusion that the scapula, which in other vertebrates overlies the ribs, has been brought to articulate by its distal end with the underside of the second rib. For this and other reasons Ogushi rejected Goette's hypothesis. Joan B. Proctor,[5] in studying the early stages of the remarkable land tortoise, *Testudo loveridgii*, found important evidence that the costal plates originated independently of the ribs.

7. RELATION OF THE HORNY SCUTES TO THE UNDERLYING BONES

Völker (his page 523) discusses the relations of the horny scutes to the underlying bones. He agrees with me that primitively the scutes coincide with the epithecal ossicles and that now in the thecophorous turtles the coincidence no longer exists. Each horny scute may cover parts of from two to as many as 10 bones. In my paper of 1898 I connected this expansion of the scutes with that of the epithecal bones, expressing the view that these bones may once have occupied most of the space now covered by the horny scutes of the living turtles. It is, however, not necessary to suppose that they were so large; although, to judge from *Chelys*, some of them must have had a respectable size. It can hardly be doubted that the scutes of the Pleurodira and the Cryptodira had their origin on the dominant epithecal bones of the keels of their early ancestors. In the primitive Thecophora the bones of the deeper layer were gaining the ascendency at the expense of the superficial ones. Although the expansion of the epithecal ossicle was checked, the overlying scute continued to grow. We must suppose further that the space between the keels was in some cases occupied by small plates of bone, as now

[4] Morphol. Jahrb., vol. 43, 1911, pp. 13–15.
[5] Proc. Zool. Soc. Lond., 1922, pp. 483–526, pls. 1–3, 21 text-figs.

in *Dermochelys*, and that each of these was capped by a horny scute. Expansion of the large scutes was probably accomplished, not by suppression of the small scutes, but by fusion with them. As the small scutes were incorporated in the various dominating ones, the underlying ossicles may sometimes have long persisted and have produced the appearances reported in my paper of 1922.

Attention may be called to the point of origin of the scutes of *Chelys* and the direction of their expansion; also to the fact that the scutes of our land and swamp tortoises develop in the same manner. The vertebral scutes of *Chelydra* and of *Clemmys* (pl. 2, fig. 2) have the focus of their growth near their hinder border and they expand forward and laterally. The center of growth of the costal scutes is usually near the upper hinder border of the area and the expansion is upward, forward, and principally downward. The focus in each marginal scute is on the edge of the carapace, at the rear end of the scute; and the growth is directed forward and away from the border on both the upper and the lower side of the shell. This correspondence of the centers of origin and growth of the scutes of all the scute-bearing chelonians furnishes strong evidence that these centers correspond to the bony patches found on the tuberosities of *Chelys* and to bones in the keels of *Dermochelys*.

It is interesting to observe that in the case of all the scutes the growth is mostly forward, very little, or not at all, backward; and it is somewhat difficult to determine the reason therefor. At present it seems probable that it is connected with the growth of the front part of the shell to the end of furnishing a retreat for the head and forelegs. This has been accomplished principally by the forward expansion of the nuchal, the first costal plates, and the anterior 2 or 3 peripherals. As the nuchal borders moved forward and laterally the growth of the first vertebral scute was in the same directions and little energy was left backward growth. Naturally the second vertebral scute grew forward to fill the space left vacant; and so for the succeeding scutes. The same explanation appears to serve for the costal and the marginal scutes.

On the lower side of the shell the anterior plastral bones expanded forward and inward. The median, or interplastral, row of epithecal bones, with their scutes, were early suppressed, so that the definitive scutes were supplied from the bones of the lateral plastral keels. As a result we find that the horny scutes have their centers of growth on the outer and rear borders.

In most Thecophora there are left few or no indications of the inframarginal keels of *Dermochelys* except perhaps the scutes at the ends of the bridges. In species of *Baëna* there is on each bridge a row of large inframarginal scutes. Where such scutes are missing

the space is filled by outward expansion of the humeral and abdominal scutes. In *Terrapene* the space is obsolete.

It seems worth while to try to account for the extension of the scutes beyond the bone on which they originate. Briefly expressed the explanation is that they were originally associated each with an epithecal bone which later ceased to support it, leaving it to wander until it reached the obstructing border of its neighbors. Sometimes parts of three or more bones are traversed to meet the boundary; sometimes only two. By the superior growth of epithecal bones along certain lines the keels of the early ancestors of turtles were produced. In the course of time some of the bones of the keels became enlarged at the expense of other bones and of the scutes overlying them. Along the middle of the back of *Toxochelys* we find enlarged epithecals reposing on the neurals. We may suppose that the most favorable position of an epithecal would be on or near a suture between two neurals, since blood vessels and nerves could more readily reach it. If now an epithecal of the size of those of *Toxochelys* were lodged across each neural suture the neural bone itself would tend to be suppressed; and among the early Thecophora the neurals themselves were gaining the upper hand. Hence about alternate epithecals were suppressed. Although the dominating epithecal was itself later dispensed with, the horny scute associated with it would expand forward to reach the scute situated the length of two neural plates in front. The same explanation will apply to the fore-and-aft width of the costal scutes, which may cover one costal bone, a part of the one behind, and a part of the one in front.

When we examine the marginal scutes we find each one covering a portion of one peripheral and a larger portion of the next peripheral in front. It seems to the writer that the explanation is as follows: The epithecals of this row were small and one for each peripheral did not menace the development of the latter. Hence its scute could spread only over a part of the next peripheral in front.

8. DR. G. K. NOBLE'S OBSERVATIONS ON CHELYS

In 1923 Dr. G. K. Noble reviewed my paper[6] of 1922 and gave an interesting account of his observations made on a young matamata of about three-eighths the size of the animal described in the present article. In his specimen he was able to find no traces of the epithecal bones. Considering this young animal in connection with the adult in which the bones were absent Noble concluded that my "hypothesis should not be accepted without additional materials." The present paper describes the additional materials desired.

[6] Amer. Naturalist, vol. 57, pp. 377–379.

It must be remembered that we are dealing with structures which, as the writer maintains, became useless thousands of generations ago and ceased to be reproduced by the great majority of turtles. It is not strange, therefore, that they appear in the matamata irregularly and in some cases not at all. Doctor Noble must recall what happens in the case of the canine teeth of mares and of the first premolars of horses in general, not to mention other similar examples.

Doctor Noble appears to suggest the attacks of parasites on these captive matamatas, but he does not pursue the subject. The life history of such a parasite would be interesting, if it exists. Doctor Noble, however, finally concludes that the ossicles in question seem to be bony deposits over injuries received either during captivity or rarely in nature. He ought to have told us whether he has observed similar bony deposits beneath the uninjured epidermal scutes of snapping turtles and terrapins kept in confinement.

9. PROCTOR'S RESULTS FROM THE STUDY OF TESTUDO

Mention has just been made of the work of Joan B. Proctor on the anatomy of *Testudo*. In her effort to determine whether the costal plates are simply expansions of the ribs or originate independently of them that author examined the recently hatched young. She found that the embryonic costal plate was in contact with the rib; also that the rib was undergoing degeneration at a time when the costal plate was growing vigorously. She concluded, therefore, that the plate was not derived from the rib. She was led to consider also the relation of the developing horny scutes to these costal plates and in doing so she hit upon a condition which, then unknown to her, had been described by Richard Owen. In the young tortoise the horny scutes are already present and relatively large. Inasmuch as the vertebral scutes alternate with the costal scutes, there is along each side of the dorsal region a zigzag series of points, from each of which radiate the edges of three scutes. The author cited found that a costal plate developed immediately under each of these triradiate structures and that the forms of these plates in their early stages of development were in strict correlation with the sutures between the superincumbent epidermal shields.

Now, with few exceptions, and these probably of secondary origin, the plates and scales of dermal bone in reptiles underlie and support the horny scutes, and the two structures agree more or less exactly in form and size. If the explanation proposed by Proctor is correct the costal plates take their origin at the intersections of the borders of three scutes and these scutes determine the early forms of the plates. The present writer believes that these conclusions are erroneous. The presence of the bones beneath the borders of the

scutes is a coincidence and these are not the cause of the ossification or of the forms of those plates. In the genus *Testudo* alternate costal plates are proximally broad, so as to articulate with three neurals; intervening ones are narrow. In the embryo figured the costals were preparing to assume those alternating forms. It will hardly be contended that the shapes finally taken by the costal plates, interlocking as they do, are determined by the horny shields. Furthermore, the proximal end of each embryonic plate is pretty certainly at the point where it quits the rib and reaches out to meet the neural plate. If the growth of the costal is determined by the epidermal shield the point where the rib becomes free ought to be just below the outer extremity of the vertebral scute. A study of the shells of a few species of tortoises will show no such relation. The vertebral shields may be very broad while the rib-heads are short.

It is the contention of the present writer that the horny shields of tortoises had primarily no relation to the costal plates, but to more superficial bones, the epithecals. As a result of the suppression of the epithecals the horny shields were brought into contact with the more deeply lodged thecal bones. In *Chelys* the epithecals are reproduced in many individuals and from these the horny scutes spread out over the thecal bones. The only effect the scutes appear to have on the thecals is to impress on their surface the radiating and concentric lines of growth. The shields do not grow at their edges merely, but a new layer of horn is laid down on its whole lower face, and these layers may often be separated from one another.

EXPLANATION OF PLATES

Plate 1

Chelys fimbriata

View of carapace from above. × 0.44

c. s. 1—c. s. 4. Costal scutes.
m. s. 1—m. s. 12. Marginal scutes.
n. s. Nuchal scute.
v. s. 1—v. s. 5. Vertebral scutes.

Plate 2

Fig. 1. *Chelys fimbriata*

View of rear of carapace from behind. × 1

To show specially the large epithecal bone on the twelfth marginal scute.
m. s. 11, m. s. 12. Eleventh and twelfth marginal scutes.
v. s. 5. Fifth vertebral scute.

Fig. 2. *Clemmys insculpta*

View of carapace from above. × 1

Shows the vertebral, costal, and marginal scutes, their areoles, the outcropping edges of the successive horny layers, and the direction of expansion.

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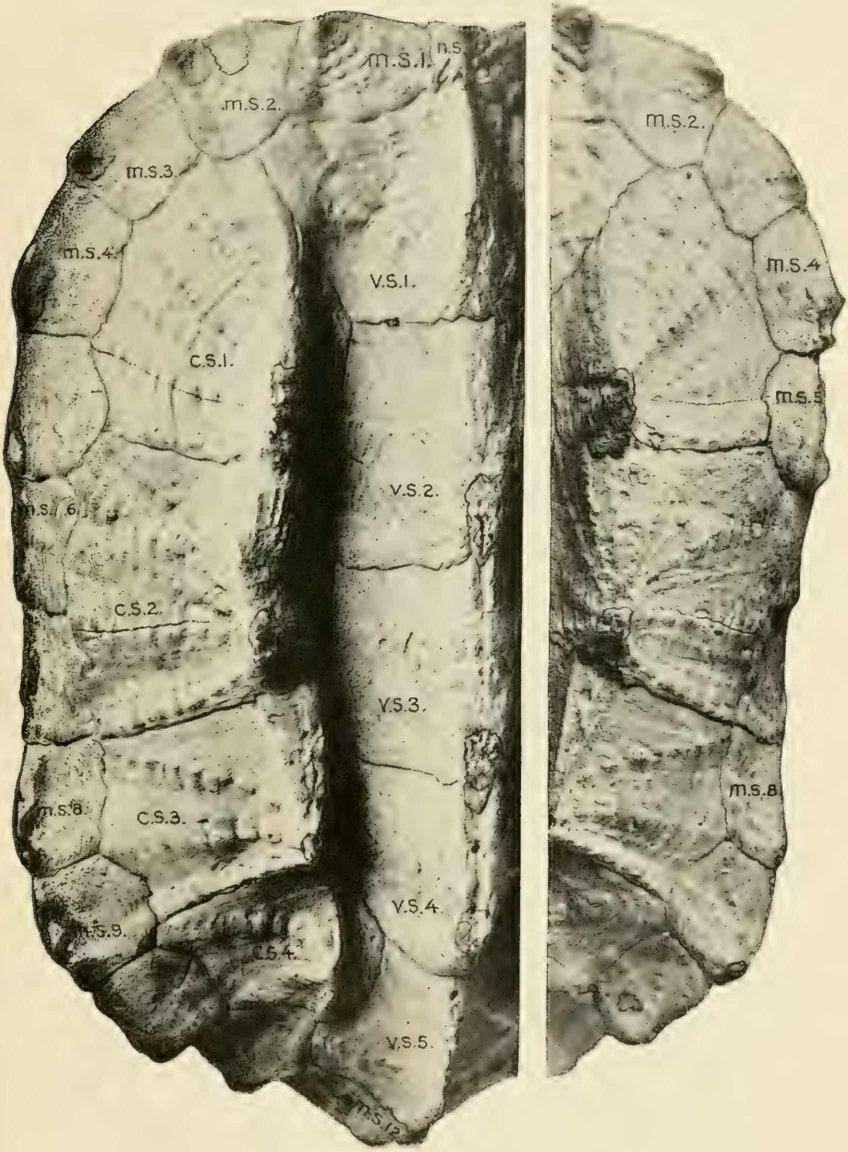
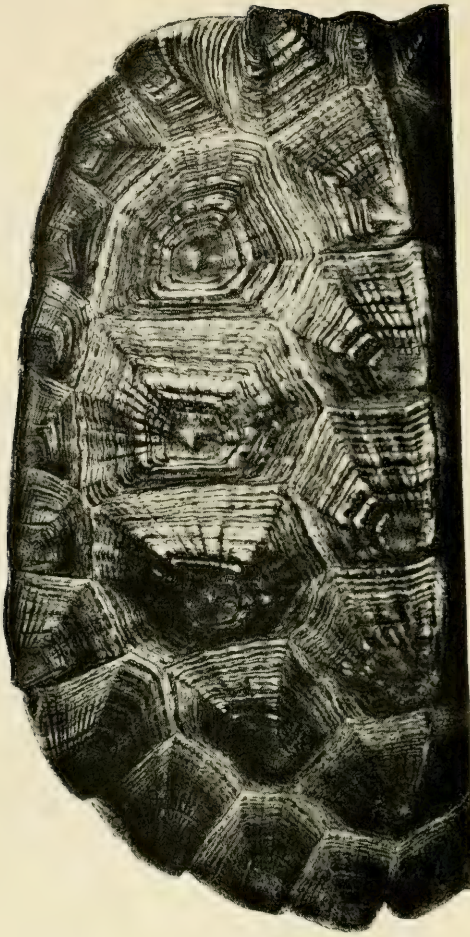


CARAPACE OF CHELYS FIMBRIATA

FOR EXPLANATION OF SEE PLATE PAGE 12



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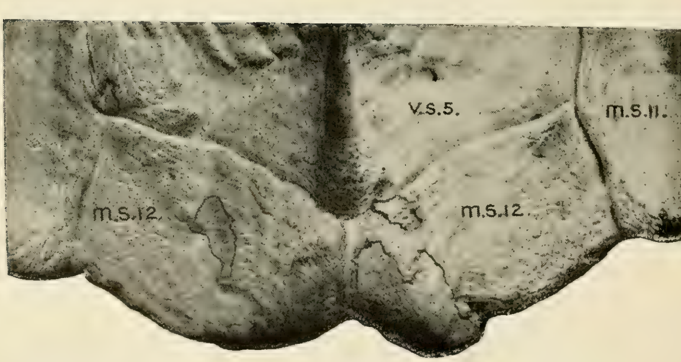

CARAPACES OF CHELYS AND CLEMMYS INSCULPTA

FOR EXPLANATION OF PLATE SEE PAGE 12

NEW HELMINTH PARASITES FROM CENTRAL AMERICAN MAMMALS

By Emmett W. Price

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Among some specimens forwarded to the Bureau of Animal Industry by Mr. Harold W. Brown of Johns Hopkins University, Baltimore, Md., were a few specimens of small nematodes which had been collected from the small intestine of a three-toed sloth, *Bradypus* sp., at Penonomé, Panama, July 17, 1926. The specific identity of the host is doubtful, since Miller (1924) lists three species of three-toed sloths, *Bradypus castaniceps*, *B. griseus*, and *B. ignavus*, from Central America. The nematodes belong in the family Trichostrongylidae Leiper, 1912, and subfamily Trichostrongylinae Leiper, 1908, two species being represented. One species appears to belong to a new genus, for which the name *Bradypostrongylus* is proposed; the other species is placed in the genus *Graphidium* Railliet and Henry, 1909.

In this paper there is also described a species of trematode which was collected by the writer from the gall bladder of a gray spider monkey, *Ateles geoffroyi*, which died in the National Zoological Park, Washington, D. C., October 8, 1926. This animal had been received from Nicaragua about two years previously. Since conditions in the monkey house are such as to practically preclude the acquirement of a trematode infestation, it is assumed that the infestation must have been acquired by the monkey before its arrival here, and presumably was acquired in Central America. This trematode belongs in the family Dicrocoeliidae Odhner, 1910, but owing to the peculiar arrangement of the testes, it has not been possible to allocate this species to any existing genus. The new genus *Controrchis* is, therefore, proposed for it.

NEMATODA

Family TRICHOSTRONGYLIDAE

BRADYPOSTRONGYLUS, new genus

Generic diagnosis.—Trichostrongylinae: Cephalic cuticle inflated and coarsely striated. Oral aperture simple; esophagus slender, varying little in diameter. Bursa of male with two large lateral

lobes and an indistinct dorsal lobe. Ventro-ventral and latero-ventral rays slightly thicker than the other rays and with their tips divergent; externo-lateral, medio-lateral, and postero-lateral rays about equal in size, parallel proximally and diverging distally; externo-dorsal ray arises from the base of the dorsal ray and is more slender than the other rays; dorsal ray thick, forming two branches distally and with each branch bifurcate; on each side of the dorsal ray, immediately in front of the two branches, a small lateral projection is present. Spicules similar, short, twisted, and with a relatively long, twisted, median process. Gubernaculum double and heavily chitinized. Telamon present. Tail of female terminates in a slender tip and is also provided with three spike-like processes. Vulva in posterior fourth of body; ovejectors and sphincters well developed; uteri divergent. Eggs oval, with thin shells of uniform thickness, and not embryonated within the uterus.

Type species.—Bradypostrongylus panamensis, new species.

BRADYPOSTRONGYLUS PANAMENSIS, new species

Specific diagnosis.—Bradypostrongylus: Cuticle of cephalic extremity inflated and coarsely striated transversely. (Fig. 1.) The expanded cuticle is about 85μ long and 50μ in diameter. The head, exclusive of the cuticular expansion, measures 32μ in diameter. The oral aperture is simple. The esophagus is about 770μ long and 52μ in diameter at the posterior extremity. The nerve ring is situated about 270μ from the anterior end. Cervical papillae not apparent.

Male 9.5 mm. long with a maximum diameter, in front of the prebursal swellings, of 156μ. The bursa (fig. 2) is large, elongated dorso-ventrally, and composed of two large lateral lobes and an indistinct dorsal lobe. The rays of the bursa, with the exception of the externo-dorsals, terminate near the edge of the bursa. The ventro-ventral and latero-ventral rays are slightly thicker than the other rays and divergent; the externo-lateral, medio-lateral, and postero-lateral rays are about equal in size and with their tips well separated; the externo-dorsal rays are more slender than the other rays and terminate some distance from the edge of the bursa; the dorsal ray is heavy and bifurcates to form two branches distally; each branch in turn bifurcates to form an incurved median branch and a long, slender, widely divergent, lateral branch. A small, cone-like lateral prominence is present on each side of the dorsal ray, immediately in front of the primary bifurcation. The cuticle in front of the bursa is expanded laterally and supported by strong prebursal papillae. The spicules are equal, 205μ long, twisted, and with a twisted filamentous process arising from the inner aspect of each spicule. (Fig. 3.) The gubernaculum is double and consists of two slightly curved,

parallel, well chitinized pieces, each measuring 44μ in length. The telamon is composed of two feebly chitinized parts embedded in the wall of the cloaca; the anterior part appears as a relatively wide band showing a deep notch in the antero-dorsal border and a similar notch in the postero-ventral border; the posterior part is composed of a narrow band extending across the dorsal wall of the cloaca and the two ends of this band appear to unite or fuse with a V-shaped structure embedded in the ventral wall. (Fig. 4.)

Female 14 mm. long and 220μ in diameter. The vulva is a transverse slit located about 3.5 mm. from the end of the tail. The tail (fig. 5) terminates in a slender filamentous tip and is also provided with three spike-like processes. The terminal filament is about 23μ long and the spines about 16μ long. The anus is located about 185μ from the tip of the tail. The ovejectors (fig. 6) are strongly muscular and with a combined length, including sphincters, of 585 to 600μ. The eggs (fig. 7) are oval, 66 to 69μ long and 33 to 40μ wide.

Host.—Three-toed sloth, *Bradypus* sp.

Location.—Small intestine.

Locality.—Central America (Penonomé, Panama).

Type specimens.—United States National Museum Helminthological Collections No. 27002.

The female of this species closely resembles that of the genus *Anoplostrongylus*, a genus proposed by Boulenger (1926) for certain trichostrongyles of bats; the male, however, appears to be more closely related to *Ornithostrongylus* Travassos, 1914, and in the key given by Yorke and Maplestone (1926) it would run out at that genus. The dorsal ray, spicules, and gubernaculum appear to be sufficiently different from those of either of the above genera to warrant the creation of a new genus.

GRAPHIDIUM BROWNI, new species

Specific diagnosis.—*Graphidium*: Cuticle of the anterior extremity slightly inflated and coarsely striated transversely. (Fig. 8.) The cuticular expansion is about 77μ long and 38μ in diameter. The body shows numerous fine, wavy striations, and is also finely striated transversely. The oral aperture is surrounded by three small inconspicuous lips. The esophagus is 650μ long in the male and 740μ long in the female, slender, slightly enlarged posteriorly, and is 32μ wide about the middle and 58μ wide at the enlarged posterior portion. The nerve ring is situated 237 to 260μ from the anterior end. The excretory pore opens ventrally 340 to 390μ from the anterior end. Cervical papillae not apparent.

Male 8.5 mm. long and with a maximum width of about 130μ in front of the bursa. The bursa (fig. 9) is composed of two lateral

lobes and a smaller inconspicuous dorsal lobe. The rays are well separated and extend to near the edge of the bursa. The ventro-ventral and latero-ventral rays are divergent and about equal in size; the externo-lateral ray is slightly thicker and longer than the other rays; the medio-lateral and postero-lateral rays are divergent; the externo-dorsal rays arise from the base of the dorsal ray and are curved dorsad near their posterior third; the dorsal ray forms two branches near its tip and each branch is bidigitate. Prebursal papillae present. The spicules are equal in length, slender, modified tubular in shape, and 532μ long. The tips of the spicules are pointed and incurved, and have a sharp pointed process on the median aspect a short distance from the tip. The shaft of each spicule appears twisted about 156μ from its anterior end. The gubernaculum is elongated, curved, well chitinized, and is 128μ long. The telamon is composed of two similar, feebly chitinized, retort-shaped structures, embedded in the ventral and lateral walls of the cloaca. (Fig. 10.) The genital cone is small, rounded, and bears two prominent papillae; these papillae are pedunculated and are situated on each side of the cloacal aperture.

Female 14 mm. long and with a maximum width of 166μ. The vulva is situated about 2.7 mm. from the posterior end of the body. The tail (fig. 11) is slender and pointed. The anus is located about 160μ from the end of the tail. The ovejectors (fig. 12) are strongly muscular and have a combined length, including sphincters, of 400μ. The eggs are oval, 64μ to 70μ long by 32μ to 38μ wide, with shells of uniform thickness, and are not embryonated within the uterus.

Host.—Three-toed sloth, *Bradypus* sp.

Location.—Small intestine.

Locality.—Central America (Penonomé, Panama).

Type specimens.—United States National Museum Helminthological Collections No. 27003.

This species differs from *Graphidium strigosum* (Dujardin, 1845), the type of the genus, in the following respects: In *G. strigosum* the spicules, according to Hall (1916), are tubular and measure 1.2 to 2.4 mm. in length; in *G. browni* they are modified tubular and their length is only about one-half of the minimum length given for *G. strigosum.* The gubernaculum in *G. browni* is long and well chitinized; in *G. strigosum* it is short and so imperfectly chitinized as to be almost invisible. In *G. strigosum* the diameter of the female diminishes abruptly behind the vulva; in *G. browni* the attenuation is gradual. The cuticular inflation of the cephalic extremity is very distinct and coarsely striated in *G. browni*, but this character is not mentioned for *G. strigosum.* An examination of the specimens of the latter species, donated to the Bureau of Animal Industry by

Professor Railliet, shows that a coarse striation of the anterior end of the body is present but the cuticular inflation is not marked.

TREMATODA

Family DICROCOELIIDAE

CONTRORCHIS, new genus

Generic diagnosis.—Dicrocoeliinae: Body oval in outline and with greatest width at the middle of the body. Oral sucker strongly muscular and directed anteriorly. Pharynx well developed; prepharynx absent. Esophagus short; intestinal ceca slender and extending to the posterior third of the body. Acetabulum large, situated about one-fourth of the body length from the anterior end. Vitellaria compact, extracecal, and not extending anteriorly beyond the posterior border of the posterior testis. Ovary oval in shape and situated immediately posterior to the posterior testis. Uterus with one ascending and one descending limb, each with numerous transverse coils, extending to the posterior end of the body. Testes oval, one lying anterior and the other posterior to the acetabulum. Genital orifice immediately behind the intestinal bifurcation. Excretory pore terminal.

Type species.—*Controrchis biliophilus*, new species.

CONTRORCHIS BILIOPHILUS, new species

Specific diagnosis.—*Controrchis:* Length 2.5 to 3 mm.; width 0.85 to 1.1 mm. In preserved specimens the anterior end is slightly curved ventrally. The anterior third of the body is covered with small scalelike spines. The oral sucker is strongly muscular, 200μ to 213μ long by 148μ to 184μ wide, and with the oral aperture terminal. The pharynx is situated immediately behind the oral sucker and measures 84μ to 99μ long by 71μ to 84μ wide. The esophagus is short, 67μ to 71μ in length, and bifurcates a short distance in front of the anterior testis to form simple, slender, intestinal ceca which extend to the posterior third of the body. The acetabulum is circular, strongly muscular, 183μ to 355μ in diameter, and situated in the median line about 500μ from the anterior end of the body. The testes are ovoid, elongated transversely; the anterior testis is situated anterior to the acetabulum and measures 140μ to 210μ by 280μ to 430μ; the posterior testis is situated posterior to the acetabulum and measures 140μ to 210μ by 350μ to 430μ. The cirrus pouch is pyriform, 142μ to 227μ long and 65μ to 100μ wide, and contains a relatively large vesicula seminalis, a small prostate, and a short ejaculatory duct. The genital orifice is situated immediately behind the intestinal

bifurcation. The ovary is oval, 99μ to 114μ by 127μ to 170μ, and is situated immediately posterior to the posterior testis. The receptaculum seminis and shell gland are located a short distance behind the ovary. The vitellaria are made up of few compact irregular follicles, occupying a space 350μ to 400μ long, on each side of the body lateral to the intestinal ceca, and not extending anteriorly beyond the level of the posterior edge of the posterior testis. The uterus consists of an ascending and decending branch and of numerous lateral coils, extending posteriorly to the posterior end of the body and anteriorly to the ovary. The eggs are small, oval, brown in color, and are 35μ to 38μ long and 21μ to 24μ wide.

Host.— *Ateles geoffroyi.*

Location.—Gall bladder.

Locality.—National Zoological Park, Washington, D. C.

Type specimens.—United States National Museum Helminthological Collections No. 27599; paratypes, No. 27369.

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EXPLANATION OF PLATES

ABBREVIATIONS

ac. acetabulum; *c. p.* cirrus pouch; *d.* dorsal ray; *e.* egg; *e. d.* externo-dorsal ray; *e. l.* externo-lateral ray; *e. p.* excretory pore; *gb.* gubernaculum; *gc.* genital cone; *g. p.* genital pore; *int.* intestine; *l. v.* latero-ventral ray; *m. l.* medio-lateral ray; *os.* oral sucker; *ov.* ovary; *ovj. 1, 2, 3,* ovejectors; *pgc.* papillae on the genital cone; *ph.* pharynx; *p. l.* postero-lateral ray; *sp.* spicules; *t.* telamon; *t. a.* anterior testis; *t. p.* posterior testis; *ut.* uterus; *vit.* vitellaria; *vul.* vulva; *v. v.* ventro-ventral ray.

PLATE 1

FIG. 1. *Bradypostrongylus panamensis.* Anterior end of female.
2. *Bradypostrongylus panamensis.* Bursa of male; dorsal view.
3. *Bradypostrongylus panamensis.* Spicules and gubernaculum; ventral view.
4. *Bradypostrongylus panamensis.* Telamon; dorsal view.
5. *Bradypostrongylus panamensis.* Posterior end of female.
6. *Bradypostrongylus panamensis.* Ovejectors.
7. *Bradypostrongylus panamensis.* Egg.

PLATE 2

8. *Graphidium browni.* Anterior end of female.
9. *Graphidium browni.* Posterior end of male.
10. *Graphidium browni.* Telamon and genital cone; ventral view.
11. *Graphidium browni.* Posterior end of female.
12. *Graphidium browni.* Ovejectors.
13. *Controrchis biliophilus.* Ventral view.

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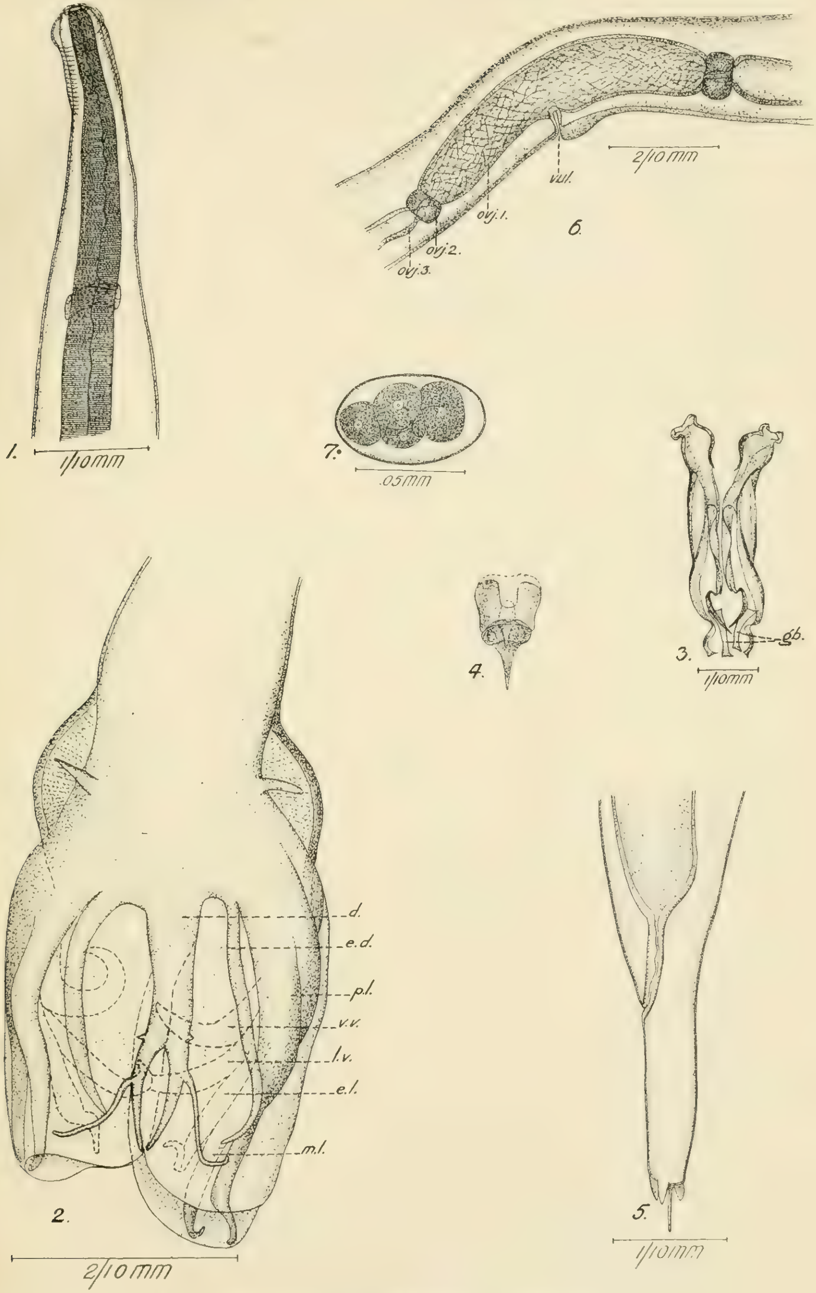
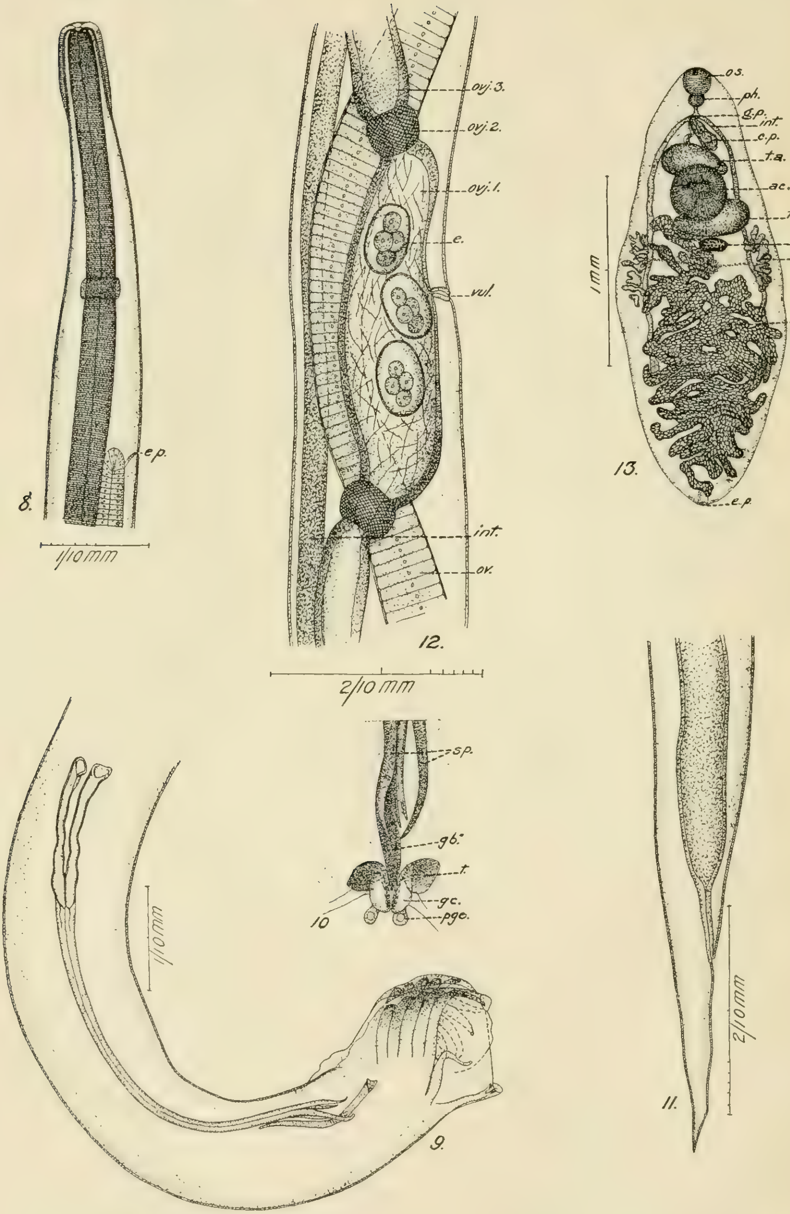


BRADYPOSTRONGYLUS PANAMENSIS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 7



GRAPHIDIUM BROWNI, NEW SPECIES AND CONTRORCHIS BIBLIOPHILUS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 7

TWO COMMON SPECIES OF PARASITIC CRUSTACEA (SACCULINIDAE) OF THE WEST INDIES

By H. Boschma

Of the University of Leiden, Holland

The chief characteristics defining the genera of the Rhizocephala concern the shape and the situation of the internal organs. One of the most important is the manner in which the visceral mass is attached to the mantle by a mesentery, which may be thin, as in *Sacculina* and allied genera, or thicker, as in *Peltogaster* and other parasites of the group. Smith (1906), the author of a monograph on the Rhizocephala, based the taxonomy of the group for a large part on the differences in the size and the place of the mesentery. This author created the new generic name *Heterosaccus*, the type species of which is *Sacculina hians* Kossmann, which is characterized by a very short mesentery. In this species it is confined to the immediate vicinity of the stalk only. According to Smith the internal structure of the other parasites of the group which live on crabs does not show any morphological differences, and consequently he united them under the name *Sacculina carcini*. In this respect, however, Smith's conclusions are wrong, for there are a number of species which can be distinguished from *S. carcini* by constant morphological features.

The mesentery of *Sacculina carcini* is complete; it stretches from the stalk to the mantle opening. In some other parasites, which have been described as species of the genus *Sacculina*, the mesentery is incomplete, for it terminates at some distance from the mantle opening. For these species of Sacculinidae with incomplete mesentery, in a recent paper (Boschma, 1927) I have founded the new genus *Drepanorchis*, the type species of which is *D. neglecta* (*Sacculina neglecta* Fraisse). Another constant feature of all the species belonging to this genus is found in the shape of the testes; they are curved, whereas in *Sacculina* they consist of more or less straight tubes.

There are a few species of Sacculinidae which in some respects constitute intermediate forms between the genera *Sacculina* and

Drepanorchis. In these species the mesentery is complete, as in *Sacculina;* the testes, however, have a curved shape, as in *Drepanorchis*. They differ from *Sacculina* as well as from *Drepanorchis* in another anatomical respect: The visceral mass is not (as in these two genera) connected with the stalk, but it is attached to the mantle at some distance from the stalk. I unite here the species which show the abovementioned characteristics under the new generic name *Loxothylacus*. Accordingly, I consider the family Sacculinidae composed of four genera with the following chief characteristics:

Sacculina: Mesentery complete, testes straight, visceral mass united with the stalk.

Loxothylacus: Mesentery complete, testes curved, visceral mass united with the mantle at some distance from the stalk.

Drepanorchis: Mesentery incomplete, testes curved, visceral mass united with the stalk.

Heterosaccus: Mesentery almost wanting (confined to the immediate vicinity of the stalk).

There are a great number of species belonging to the Sacculinidae, although this number is smaller than Giard (1887, 1888) assumed, who upheld that every species of crab had its own species of rhizocephalous parasite. This theory (the theory of the absolute specificity of the parasites) has been combated by Smith (1906), who, however, went to the other extreme and expressed as his opinion that all the parasites of the genus *Sacculina* belong to one and the same valid species, *S. carcini* Thompson. Smith based this conclusion on the fact that he found no morphological differences between the parasites on different crabs in the material at his disposal. Now, this conclusion also was too far-reaching, for Giard (1887) had proved already that the parasite called by him *Sacculina fraissei* (=*Drepanorchis neglecta* (Fraisse), see Boschma, 1927) differs from *S. carcini* in constant morphological characteristics, the form and situation of the testes in both species being very different. Moreover, Kossmann (1872) had described morphological differences between species of Sacculinidae which were found on different hosts. His diagnoses of new species were based mainly on the structure of the chitinous covering of the mantle, which in many cases bears definitely shaped small excrescences. Kossmann also was convinced that a certain species of *Sacculina* could live on one species of host only and accordingly described too many forms as new species. The discovery of the appendages of the cuticle, however, was a valuable progress in the study of the Sacculinidae as it furnishes reliable data for the taxonomy of the group. Especially in tropical species (Kossmann's material had been collected at the Philippine Islands) these small projecting parts of the external cuticle are distinctly visible. In the same way in the collection of the Siboga

Expedition from the East Indian Archipelago also, the greater part of the Sacculinidae are sufficiently characterized by the peculiar structure of the excrescences on the external cuticle of the mantle (Van Kampen and Boschma, 1925). In the paper cited we were able to prove that a number of morphologically well defined species of *Sacculina* occur in the East Indies. Two more striking facts were observed, first, that a single species may occur as a parasite of several species of crabs, and, second, that certain species of crabs may be infested with two or more different species of *Sacculina*. Consequently this paper proves conclusively that the opinions of Giard as well as Smith can not be upheld.

A comparative study of a great number of European representatives of the genus *Sacculina* (Boschma, 1927) yielded almost the same results: Among the European forms one species of parasite may infest different species of crabs, as in the case of *Sacculina carcini*. In this region, however, two morphologically different species have never been found as parasites on one species of host. Previously Guérin-Ganivet (1911) published a paper in which notes were given on the anatomy of many European Sacculinids, and this author has already pointed out that a great number of the so-called species of Giard's have no real systematic value. According to Guérin-Ganivet we may regard a certain form as a definite species only in those cases in which morphological differences from other species can be demonstrated. In the paper cited I based my conclusions on the same premises.

In some cases a certain parasite infests exclusively crabs belonging to a small systematic group, as *Drepanorchis neglecta* (Fraisse), which is known to occur on the species of the genera *Macropodia* and *Inachus*. Both of these genera belong to the subfamily Inachinae (family Majidae) and the parasite, which is structurally very different from all other known European Sacculinids, is the only species of the group which is known to infest these crabs. The parasite of *Dorynchus thomsoni*, another species of the same subfamily, belongs to quite a different species (*Sacculina atlantica*), which is not found on any other crab. Another well defined species, *Sacculina eriphiae*, also seems to occur on one species of crab only, namely, *Eriphia spinifrons*. On the other hand *Sacculina carcini* infests a large number of hosts belonging to different families of Brachyura.

The West Indian species of Sacculinidae are very imperfectly known. One species has been described as *Sacculina panopaei* by Gissler (1884) after its host *Panopeus herbstii* (Milne-Edwards). The external form of this parasite is known, for the description is accompanied by two text-figures; its internal anatomy and the structure of its cuticle have not been described in the cited paper. Fortunately

my material includes a number of specimens which undoubtedly belong to the same species and a diagnosis of this species is found in the following pages. The study of its anatomy proves that it belongs to the genus *Loxothylacus*.

In the West Indian region, however, more than one species of Sacculinidae occur. Besides that described by Gissler, this family is represented by many other species, as I demonstrated a few years ago when I examined the material collected by Dr. Van der Horst at Curaçao (Boschma, 1925). Three specimens of *Sacculina* were represented in this collection, each of which constituted the type specimen of a new species.

Although there are a great number of West Indian species of Sacculinidae, only two seem to occur as common forms. One of these is Gissler's species, the other, which is described in the present paper under the name *Drepanorchis occidentalis*, has not been recorded before. It is an interesting fact that each of these species is found on several species of crabs, but each infests a definite group of systematically related hosts. *Drepanorchis occidentalis* lives on crabs of the family Majidae, whereas *Loxothylacus panopaei* is known as a parasite of *Panopeus* and nearly allied genera, all of which are representatives of the family Xanthidae. Consequently just as in European species the Sacculinidae of the West Indian region are restricted to definite families of crabs within which these two common parasites infest several different species.

The descriptions of the two species that follow are entirely based on the material of the United States National Museum, in which both are represented by a number of specimens.

DREPANORCHIS OCCIDENTALIS, new species

Type.—Cat. No. 60608, U.S.N.M., on *Mithrax forceps* (A. M.-E.), "Fish Hawk" Sta. 7153. Deadman's Bay, west coast of Florida.

The shape of the animals is roundish or somewhat irregular, often with more or less well-marked angular tips. (Fig. 1.) The size is variable, some specimens have a greater diameter of 4 mm. or less, whilst others are much larger. The largest specimen in the collection (fig. 1*c*, *d*) measures 11.5 mm. from the dorsal to the ventral surface (the diameter at right angles with the axis through the mantle opening and the stalk). As in other species of Sacculinidae the size of the parasites depends at least partially on the size of their hosts: The larger specimens are found on crabs belonging to species which may attain a comparatively large size.

The mantle opening, which lies approximately opposite the stalk, is rather wide. It is often surrounded by a wall-shaped projection of the mantle, which may form a tubelike expansion.

The internal anatomy of the species resembles strongly that of the type species of the genus, *Drepanorchis neglecta* (see Boschma, 1927). The closed end of the testes in *D. occidentalis* is found in the posterior part of the visceral mass (nearer to the stalk than to the mantle opening); in *D. neglecta* this part of the testes is situated at a comparatively greater distance from the stalk. The testes of *D. occidentalis* have a fairly large size. (Fig. 2.)

The colleteric glands occupy about the center of the lateral surfaces (in *D. neglecta* these organs are much nearer to the mantle opening). The colleteric glands contain a comparatively small number of branched tubes.

FIG. 1.—TWO SPECIMENS OF DREPANORCHIS OCCIDENTALIS. *a*, FROM MITHRAX FORCEPS (A. MILNE-EDWARDS), THE SURFACE LYING AGAINST THE THORAX OF THE HOST, × 3¾. *b*, THE SAME SPECIMEN, THE SURFACE LYING AGAINST THE ABDOMEN OF THE HOST, × 3¾. *c*, FROM MACROCOELOMA CAMPTOCERUM (STIMPSON), THE SURFACE LYING AGAINST THE THORAX OF THE HOST, × 3. *d*, THE SAME SPECIMEN, THE SURFACE LYING AGAINST THE ABDOMEN OF THE HOST, × 3. IN THESE FIGURES THE MANTLE OPENING IS FOUND IN THE UPPER PART, THE STALK IN THE LOWER PART

The typical characteristics of *D. occidentalis* are those of the external and internal cuticle of the mantle. The external cuticle is a thin layer of chitin; its thickness does not exceed 10μ. It has a smooth surface without any excrescences. Seen from above the surface is divided into small areas which have a diameter of 10 to 15μ and are surrounded by more or less meandering lines. (Fig. 3 *a*, *b*.)

On the internal cuticle of the mantle a great number of retinacula are found, more than in any other species of Sacculinid. (Fig. 3, *c–h*.) The internal cuticle is divided into small areas of approximately 100μ diameter; in detached pieces of this cuticle the marginal parts of these areas are more or less wrinkled. Each of these small

areas bears one or two retinacula. (Fig. 3*d*.) The retinacula are about 30μ long; their broadened basal part is surrounded by a circular groove at the place where they are attached to the cuticle. The apical part of the retinacula bears 5 to 10 spindle-shaped excrescences of about 15μ length, which are provided with small lateral barbs. (Fig. 3 *e–h*.)

In the material of the United States National Museum *Drepanorchis occidentalis* occurs on the following hosts:

Macrocoeloma camptocerum (Stimpson); of Florida.

Macrocroeloma diplacanthum (Stimpson); Cuba.

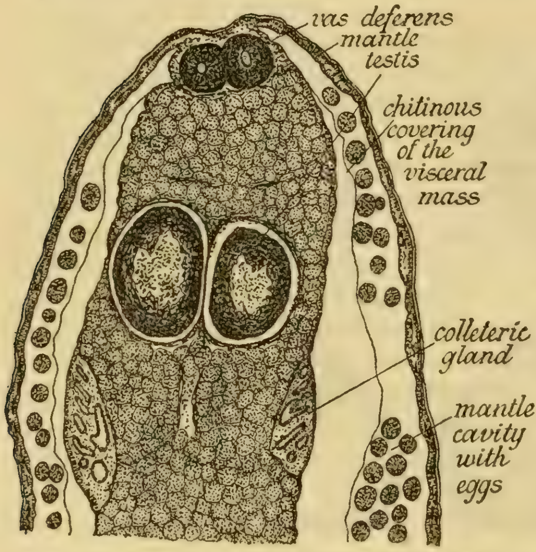


FIG. 2.—DREPANORCHIS OCCIDENTALIS FROM MITHRAX FORCEPS (A. MILNE-EDWARDS), LONGITUDINAL SECTION, × 30

Microphrys bicornutus (Latreille); off Florida; Cuba; Bahamas.

Mithrax forceps (Herbst); Bahamas.

Mithrax forceps (A. Milne-Edwards); west coast of Florida. (Host of type.)

Mithrax sculptus (Lamarck); Jamaica.

Pitho anisodon (von Martens); off Florida.

Pitho lherminieri Schramm; Key West or west coast of Florida.

Stenocionops furcata coelata (Milne-Edwards); off Florida.

Among these crabs the species of the genera *Macrocoeloma*, *Microphrys*, and *Mithrax* belong to the family Periceridæ, and the family Majidæ is represented by the genera *Pitho* and *Stenocionops.*

LOXOTHYLACUS, new genus

Body laterally compressed, mantle opening opposite the stalk. Visceral mass attached to the mantle at some distance from the stalk. Mesentery thin, extending from the place where the visceral mass is united with the mantle to the mantle opening. Colleteric glands with a number of branched tubes, in or near the central part of the lateral surfaces of the visceral mass. Testes curved, the convex part running along the mesentery.

The type species of this genus is *Sacculina corculum* Kossmann. Among my material I have complete series of sections of three specimens belonging to this species. All of these have a complete mesentery and curved testes, whilst the visceral mass is united with the mantle at some distance from the stalk.[1] Kossmann's figure of the type species does not show distinctly the unusual place of the stalk.[2] The other characteristics of the genus (the curved testes and the complete mesentery) are clearly drawn in another figure by the

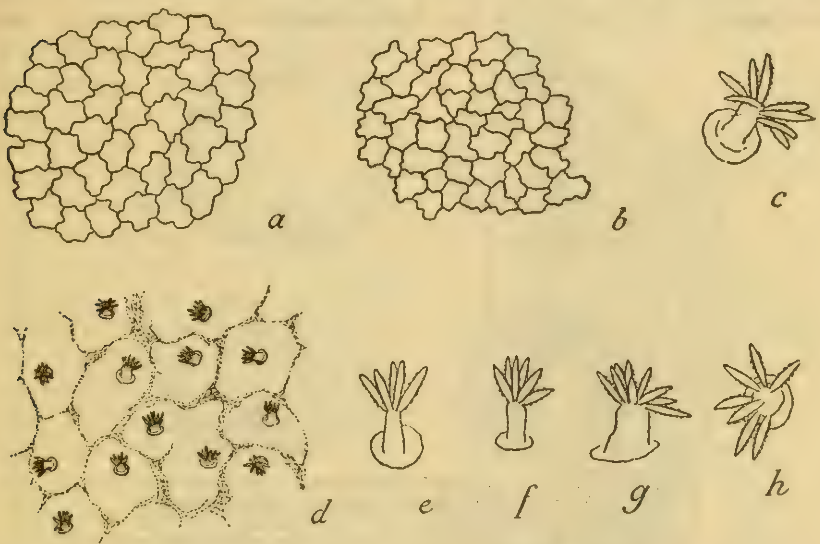


FIG. 3.—DREPANORCHIS OCCIDENTALIS. *a*, PART OF THE EXTERNAL CUTICLE OF A SPECIMEN FROM PITHO ANISODON (VON MARTENS), × 440. *b*, PART OF THE EXTERNAL CUTICLE OF A SPECIMEN FROM MITHRAX FORCEPS (A. MILNE-EDWARDS), × 440. *c*, RETINACULUM OF A SPECIMEN FROM MACROCOELOMA CAMPTOCERUM (STIMPSON), × 440. *d*, INTERNAL CUTICLE WITH RETINACULA OF A SPECIMEN FROM MICROPHRYS BICORNUTUS (LATREILLE), × 110. *e*, RETINACULUM OF A SPECIMEN FROM MITHRAX SCULPTUS LAMARCK, × 440. *f*, RETINACULUM OF A SPECIMEN FROM PITHO ANISODON (VON MARTENS), × 440. *g* AND *h*, RETINACULA OF A SPECIMEN FROM MICROPHRYS BICORNUTUS (LATREILLE), × 440

same author.[3] Probably the first of Kossmann's above cited figures was not altogether correct, for all other peculiarities of my specimens closely fit in with this author's description. As in the type specimen their external cuticle is provided with long and stout spines. On account of the last-named feature the species *Loxothylacus corculum* (Kossmann), is one of the best characterized species of the whole family. The West Indian species which is described below differs from *L. corculum* especially in the smaller size of its cuticular excrescences.

[1] See Van Kampen and Boschma, 1925, pl. 2, fig. 3.
[2] See Kossmann, 1872, pl. 2, fig. 5*b*.
[3] Idem. pl. 2, fig. 5*a*.

LOXOTHYLACUS PANOPAEI (Gissler)

Sacculina panopaei GISSLER, 1884

The animal has a roundish shape; in some cases the mantle has more or less distinctly marked tips. (Fig. 4.) The size is variable, though in general the parasites of this species are small; the largest specimen in the collection has a greater diameter of about 6 mm.

The mantle opening lies at the top of a small tube-like expansion of the mantle, which is usually directed towards the surface which lies against the thorax of the host. In the type specimen (see

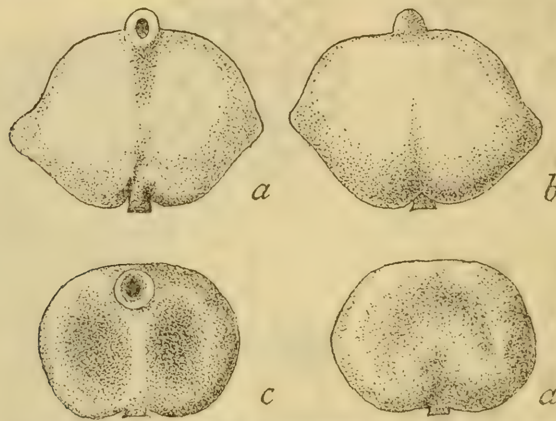


FIG. 4.—TWO SPECIMENS OF LOXOTHYLACUS PANOPAEI (GISSLER). *a*, FROM PANOPEUS HERBSTII MILNE-EDWARDS, THE SURFACE LYING AGAINST THE THORAX OF THE HOST, × 7½. *b*, THE SAME SPECIMEN, THE SURFACE LYING AGAINST THE ABDOMEN OF THE HOST, × 7½. *c*, FROM EURYPANOPEUS DEPRESSUS (SMITH), THE SURFACE LYING AGAINST THE THORAX OF THE HOST, × 7½. *d*, THE SAME SPECIMEN, THE SURFACE LYING AGAINST THE ABDOMEN OF THE HOST, × 7½. IN THESE FIGURES THE MANTLE OPENING IS FOUND IN THE UPPER PART, THE STALK IN THE LOWER PART

Gissler, 1884, figs. 1 and 2) this tubular expansion of the mantle also is well developed.

In the accompanying figure (fig. 5), a longitudinal section parallel to the dorsal and the ventral surfaces, all the characteristics of the genus *Loxothylacus* are visible: The stalk is attached to the mantle at some distance from the visceral mass, a section of the closed part of one of the testes is found in the posterior part of the visceral mass, and in the lower part of the figure (consequently in the anterior part of the animal) the visceral mass is attached to the mantle by the mesentery. The section is from the immediate vicinity of the mantle opening, a part of the sphincter which surrounds the mantle opening is visible in the lower part of the figure.

The testes are strongly curved, their extremity lies at a short distance from the vasa deferentia (in *L. corculum* the closed end of the testes lies much nearer to the mantle opening). The colleteric glands occupy about the central part of the lateral surfaces; they contain a large number of tubes.

The external cuticle of the mantle is rather thin, 8–12μ approximately. Its upper surface consists of small areas which have an irregular contour; the diameter of these areas is about 9–12μ. In some of the specimens of the material each of the cuticular areas bears a small spine (fig. 6*b*); in other specimens a much smaller number of these spines occurs, as only about one-fourth of the total number of areas has such an excrescence (fig. 6*a*). These spines are tapering from the base to the top, which is evenly rounded; they may attain a length of 20μ and a thickness (at the base) of 3μ. In different parts of the mantle of one specimen of L. *panopaei* the spines may be of different sizes. (See fig. 6*c*, *d*.) On the whole the differences between the cuticular excrescences of different specimens (even those which live on different hosts) are not more striking than those found among the spines of different parts of the mantle of one specimen.

FIG. 5.—LOXOTHYLACUS PANOPAEI (GISSLER) FROM EURYPANOPEUS DEPRESSUS (SMITH), LONGITUDINAL SECTION, × 30

The internal cuticle of the mantle bears small retinacula (fig. 6, *g-i*) which consist of a very insignificant basal part and a number (3 to 5) of spindle-shaped excrescences of 6–9μ length. Lateral barbs could not be detected on these spindles.

The material of the United States National Museum contains specimens of *Loxothylacus panopaei* on the following hosts:

Panopeus occidentalis (Saussure); Porto Rico.

Eurypanopeus depressus (Smith); Florida (?); Texas.

Panopeus herbstii Milne-Edwards; Jamaica; Cuba.

Gissler's specimen on which the original description of the species was based was a parasite of *Panopeus herbstii*, collected on the coast of Florida (Tampa).

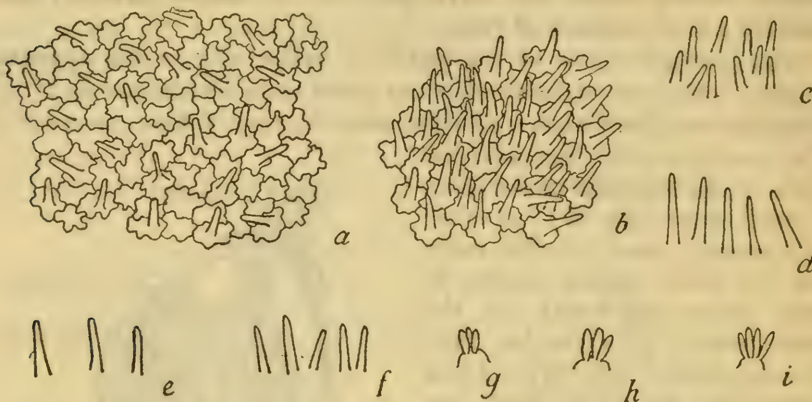


FIG. 6.—LOXOTHYLACUS PANOPAEI (GISSLER). *a*, PART OF THE EXTERNAL CUTICLE OF A SPECIMEN FROM EURYPANOPEUS DEPRESSUS (SMITH), × 440. *b*, PART OF THE EXTERNAL CUTICLE OF A SPECIMEN FROM PANOPEUS HERBSTII MILNE-EDWARDS, × 440. *c* AND *d*, APPENDAGES FROM TWO DIFFERENT PLACES ON THE EXTERNAL CUTICLE OF A SPECIMEN FROM PANOPEUS HERBSTII MILNE-EDWARDS, × 440. *e*, CUTICULAR APPENDAGES OF ANOTHER SPECIMEN FROM PANOPEUS HERBSTII MILNE-EDWARDS, × 440. *f*, CUTICULAR APPENDAGES OF A SPECIMEN FROM PANOPEUS OCCIDENTALIS (SAUSSURE), × 440. *g*, RETINACULUM OF A SPECIMEN FROM EURYPANOPEUS DEPRESSUS (SMITH), × 440. *h*, AND *i*, RETINACULA OF TWO DIFFERENT SPECIMENS FROM PANOPEUS HERBSTII MILNE-EDWARDS, × 440

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○

TWO NEW CRABS FROM THE EOCENE OF TEXAS

By Mary J. Rathbun

Associate in Zoology, United States National Museum

The species here described come from the same general region in Texas. The Raninid was taken in a core drill, Lane No. 1, depth 260 feet, by the Marland Oil Co., a part of the Thomas Jordan Survey of land in Navarro County. The Lane farm is located about 4 miles north of Kerens and 8 or 10 miles west-southwest of Tool in Henderson County. Until now the genus *Notosceles* was known from only one species, a Recent one.

The Xanthid was collected by John E. Adams, Bureau of Economic Geology, Austin, Tex., in the bed of Little Brazos Creek, Brazos County, on both sides of the old Bryan and Brazos Valley Railroad bridge.

The type-specimens are in the United States National Museum.

Family RANINIDAE

Genus NOTOSCELES Bourne

Notosceles Bourne, Journ. Linn. Soc., Zool., London, vol. 35, 1922, p. 73; type, *N. chimmonis* Bourne, a Recent species from the Sulu Sea.

NOTOSCELES BOURNEI, new species

Plate 1

Raninoides sp. Rathbun, in Hull, Bull. Amer. Assoc. Petroleum Geologists, vol. 9, No. 1, 1925, p. 169.

Carapace (pl. 1, fig. 4) about two-thirds as wide as long, widest at the middle of its length, lateral spine in front of middle of anterolateral margin. Surface minutely punctate, punctae close together; except on the frontal and orbital regions where the surface is densely and roughly granulate. The granulation begins just in front of the base of the lateral spine and at the end of a curved (convex forward) ridge which passes obliquely forward to a point just behind the inner of the orbital fissures and then transversely behind the front;

the surface of the ridge as well as the space anterior to it is granulate. Front with a sharp well advanced median tooth with a small tooth on either side; outline obscure but the accessory tooth points obliquely outward. Orbital slits deep and open, the inner sinus longer than the outer, its outer margin exceeding the inner margin, while the reverse is true of the outer sinus; margin between the sinuses oblique and nearly straight. Outer orbital tooth broad, tipped by a long, but thick and slightly curved spine, convex outside. The antero-lateral spine of the carapace is similar to the orbital spine but longer; it also is curved but directed very slightly outward, but not so far as the line of the widest part of the carapace. The postero-lateral margin is slightly sinuous and marked by a raised line formed by a single row of close granules; it rounds into the truncate posterior margin. Length of carapace 12.6, width 8 mm. The above description is made from a small specimen imbedded in a cross section in such a way that only the dorsal surface of the carapace is exposed. Cat. No. 369608, U.S.N.M.

Fortunately another specimen showing sternal as well as dorsal surface was taken previously from the Midway, basal Eocene, near Kerens, Navarro County; it was submitted to Dr. W. L. Stephenson by D. W. Ohern, Borealis Oil Co., Oklahoma City. This specimen lacks the frontal and orbital regions; it measures 25.6 mm. in length up to the anterior base of the lateral spine; approximate width 22 mm., estimated length 34.6 mm. Carapace (pl. 1, fig 1) very convex from side to side, high in the middle where it forms a broad smooth ridge; either side of it on the posterior half of the carapace there is a shallow depression; at the widest part of the carapace on the left side (the right side is broken away) there is a large round smooth boss. I am not sure that this is natural to the crab as it looks much like a swelling due to parasitism.

Additional occurrence.—Two specimens were taken in the Midway of southwestern Arkansas at Buzzard Bluff, sec. 16, T. 14 S., R 26 W., Miller County, by J. P. D. Hull, and were returned to him.

Comparison with type-species.—So far as the carapace and sternum (pl. 1, fig. 2) are concerned this species agrees in all essentials with the Recent or type-species of the genus. The postero-lateral margins converge more rapidly and the posterior margin is correspondingly shorter than in *N. chimmonis*. The lobe at the middle of the supra-orbital margin is subquadrate instead of triangular.

Family XANTHIDAE

Genus HARPACTOCARCINUS A. Milne Edwards

Harpactocarcinus A. MILNE EDWARDS, Ann. Sci. Nat., Zool., ser. 4, vol. 18, 1862, pp. 46 and 64; type, *H. punctulatus* (Desmarest) from the Eocene of Priabona.

HARPACTOCARCINUS AMERICANUS, new species

Plates 2 and 3

The specimens were obtained chiefly from the interior of concretions, but the material was so friable that the fossils broke into many pieces. One female and one male were in a layer 10 feet below the concretions; they are used as holotype and paratype.

Diagnosis.—Lateral teeth behind the orbit five, very small. Surface of carapace uneven in posterior two-thirds. Chelipeds similar and of moderate size in the female, unequal in male, the major one of enormous size, the fingers greatly elongate.

Description.—Carapace of female holotype (pl. 2, fig. 3) very little broader than long; chord of antero-lateral margin nearly as long as postero-lateral margin, and amply rounded; postero-lateral margin slightly sinuous, nearly straight. Surface very convex, more so from front to back than from side to side; punctate and very finely granulate. From either side of the widest part of the mesogastric region a broad, nearly longitudinal furrow runs back to the intestinal region stopping short of the posterior margin. A large but low swelling occupies the inner angle of the branchial region, and a larger but less well defined one adjoins it in an anterolateral direction. From the lateral tooth a very blunt ridge runs backward and inward and upward on to the dorsal surface. At the end of this ridge and a little above and within the postero-lateral margin there is a round shallow depression. The postero-lateral margin is very thick and not clearly defined, the antero-lateral is thin but blunt and furnished with five small teeth behind the orbit; their tips are for the most part broken off; the anterior or first tooth is very slight, scarcely a tooth but a very oblique angle in the margin; the other teeth appear to be normal to the margin, the second one very small, the third and fourth larger and perhaps subequal, the fifth probably considerably larger, judging from a section of the base. The intervening sinuses are unequal and in the order of their length on the left side are 1.3.2.4.5, the first sinus longest, the fifth shortest. On the right side the first tooth is nearer the orbit. The upper margin of the orbit is approximately a semicircle viewed from above, the outer angle narrow and well advanced; at the lower inner angle there is a strong, conical, subacute tooth, more advanced than the outer tooth.

The under side of the carapace (pl. 2, fig. 4) is more coarsely granulate than the upper, the granules more distant; on the margins and along the pterygostomian ridge the granulation is fine and close. The remains of the buccal cavity and the outer maxillipeds indicate the following: The buccal cavity widens forward, its anterior margin sinuous. The exognath and endognath of the maxillipeds are wide, the exognath widest at the middle; endognath obliquely placed, ischium widening distally, merus obliquely placed, its anterior margin fitting against the arch of the buccal margin. On the sternum at the base of the cheliped and either side of the proximal end of the terminal segment of the female abdomen there is a large tubercle obliquely compressed. The first five segments of the mature abdomen are short, the sixth is nearly twice as long as the fifth, measured at the middle, and is longer at the sides, the distal margin being a broken line; terminal segment not quite so long. Surface coarsely and unevenly punctate. Length of carapace approximately (front margin broken off) 35 millimeters; width to base of lateral tooth, 44.6; fronto-orbital width, 23 millimeters. Cat. No. 369607, U.S.N.M.

A pair of loose chelae, one with fingers (pl. 2, figs. 1 and 2), may belong to the holotype as they have the same rusty coloration and gloss. Left palm about two-thirds as high as right. A large tubercle opposite the digital sinus and an oblique line of three tubercles on the proximal half; the upper and middle tubercles are elongate and similar, the middle one shorter; the lowest one is conical; a lobe on inferior margin at proximal end. Upper margin incomplete in both palms but having three large tubercles, while the hinder portion in the smaller palm is produced in a lamina bearing three smaller tubercles (fig. 2, *3t*). An outer margin of the upper surface shows a few low swellings. The inner surface (pl. 2, fig. 2) has through the middle a short longitudinal line of granules, three on the larger palm, four on the smaller. Fingers of the larger chela similar, short, triangular in side view; prehensile edge largely occupied by two huge, low molariform teeth or tubercles.

Paratype *a*: One concretion yielded not only the body of a crab but a manus. The front between the eyes is fairly well shown (pl. 2, fig. 6); the median teeth are separated by a very shallow sinus and are only slightly in advance of the lateral pair.

Paratype *b* (pl. 2, fig. 5) shows the position of the outer maxillipeds and the basal antennal article (*a*).

Males.—Paratype *c*: The male (pl. 3, figs. 1 and 2) which was found outside a concretion is much larger than any of the females; carapace about 72 millimeters wide, but so damaged that few characters are discernible. One lateral tooth (perhaps the third) remains (pl. 3, fig. *2t*); it is strong, conical, obliquely upturned; the inter-

mediate marginal granules are of important size, almost tubercles. The surface is more even than in the smaller females. The right cheliped is present and the stumps of three ambulatory legs (pl. 3, fig. 1). Cheliped massive, its chela as long as the carapace is wide. Surface of carpus and chela coarsely granulate. Carpus (pl. 3, fig. 2) a little longer than wide; on the upper side a shallow groove runs parallel to the distal margin. Chela strongly curved both crosswise and lengthwise following the conformation of the lower surface of the body. Palm (pl. 3, fig. 1) increasing rapidly in height from the proximal to the distal end, but not attaining a height equal to its length. The outer surface is bent strongly over horizontally to form an upper surface (pl. 3, fig. 2); the lower margin is very concave, accented by the strongly deflexed finger. Outer surface (pl. 3, fig. 1) with a high conical swelling (*s*) opposite the interdigital sinus and further back from the margin than in the female; of the three proximal tubercles only the uppermost (*r*) is preserved, a short longitudinal ridge highest at its middle and sloping down to either end. Upper surface of palm (pl. 3, fig. 2) oblique and convex in both directions except at the distal end, where there is a depression; its inner margin is marked by a row of four large tubercles on the proximal half and a suggestion of two others on the distal half; its outer margin has near the middle three or four small and very low tubercles. Fingers very broad at the base where they meet when closed, but rapidly tapering to long, narrow, thick fingers, broad-oval in cross section, with subacute tips. Each finger (pl. 3, fig. 1) has at base on the occludent margin a large conical tooth or tubercle, the dactylar tooth folding within or proximal to the propodal tooth. Near the middle of the dactylus is a similar though smaller tooth; extremity of immovable finger unknown. The stump of the merus of the left cheliped suggests that the latter was much smaller than the right cheliped. The merus of the ambulatory legs is long and narrow, the cross section narrow-oval.

Paratype *d:* Distal half of dactylus of a larger male chela than any preserved showing a part of the large tooth at middle (pl. 3, fig. 5*t*. Paratype *e:* A much worn left palm of medium size with stumps of fingers. The remoteness of the large tubercle from the fingers indicates a male. Paratype *f:* A piece of a left cheliped comprising merus and carpus (pl. 3, fig. 3); the former is short and stout, not quite so high as long, its margins bluntly rounded except at the proximal end of the lower outer margin, which is drawn to a thin, sharp edge (*t*). The subtriangular outer surface of the carpus ends proximally in a projecting point (*p*). Sex indeterminable.

H. americanus, the first species of the genus to be described from the American continent, resembles several European species. In its

few and small lateral teeth it is like *H. quadrilobatus* (Desmarest),[1] and *H. souverbiei* (A. Milne Edwards);[2] in the shape of the major chela of the male it resembles *H. macrodactylus* (Milne Edwards);[3] while the astonishing sexual dissimilarity and inequality of the chelipeds is paralleled by *H. punctulatus* (Desmarest), which is described at length from abundant material by A. Milne Edwards.[4] The chelae of the female are of the same type as those of *Zanthopsis leachii* (Desmarest)[5] and have similar ornamentation. The carapace of *H. americanus*, however, though uneven is not lumpy as it is in even the smoothest of the *Zanthopsis* species.

EXPLANATION OF PLATES

Plate 1

Notosceles bournei

Figs. 1–3. Paratype, near Kerens, Navarro County, dorsal view, × 1½. 1. Dorsal view. 2. Ventral view. 3. Left profile, ventral side uppermost.

4. Holotype, 4 miles N. of Kerens, dorsal view, × 10.

Plate 2

Harpactocarcinus americanus

Figs. 1 and 2. Chelae, supposedly of holotype, × 1½. 1. Outer view. 2. Inner view; *3t*, 3 tubercles on lamina.

3 and 4. Holotype, ♀, × 1½. 3. Dorsal view. 4. Ventral view.

5. Paratype *b*, ventral view, × 2; *a*, basal article of antenna.

6. Paratype *a*, ♀, fronto-dorsal view, × 2.

Plate 3

Harpactocarcinus americanus

Figs. 1 and 2. Paratype *c*, ♂, × 1½. 1. Ventral view; *e*, end of movable finger; *r*, uppermost of 3 proximal tubercles on palm; *s*, conical swelling opposite interdigital sinus. 2. Dorso-frontal view; *t*, sole antero-lateral tooth; *r* and *s*, as above.

3. Paratype *f*, merus and carpus of left cheliped, upper-outer view, × 1½; *p*, posterior angle of carpus; *t*, thin proximal-outer edge of merus.

4. Merus of a left ambulatory leg, outer view, × 2.

5. Paratype *d*, left dactylus of ♂, outer view, × 1½; *t*, tooth at middle.

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[1] A. Milne Edwards, Ann. Sci. Nat., Zool., ser. 4, vol. 18, 1862, pl. 4, fig. 1.

[2] Idem, pl. 6, fig. 3.

[3] Idem, pl. 10, fig. 1*a*.

[4] Idem, pp. 68–70, pl. 8, figs. 1, 1*a*; pl. 9, figs. 1, 1*a*.

[5] Bell, Monograph Foss. Malac. Crust. Great Britain, pt. 1, 1857 (publ. 1858), pl. 1, fig. 3.

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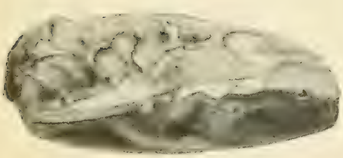

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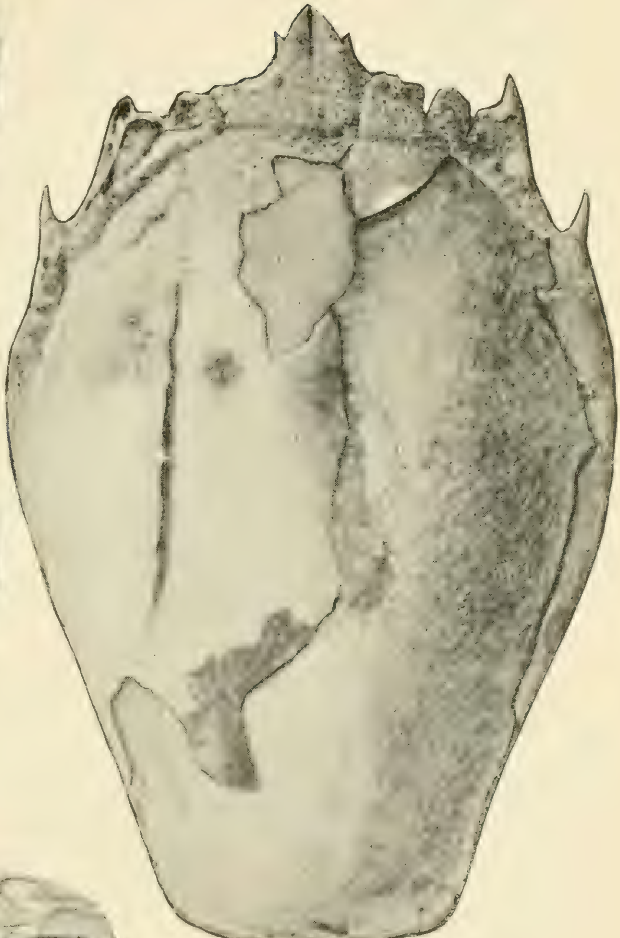

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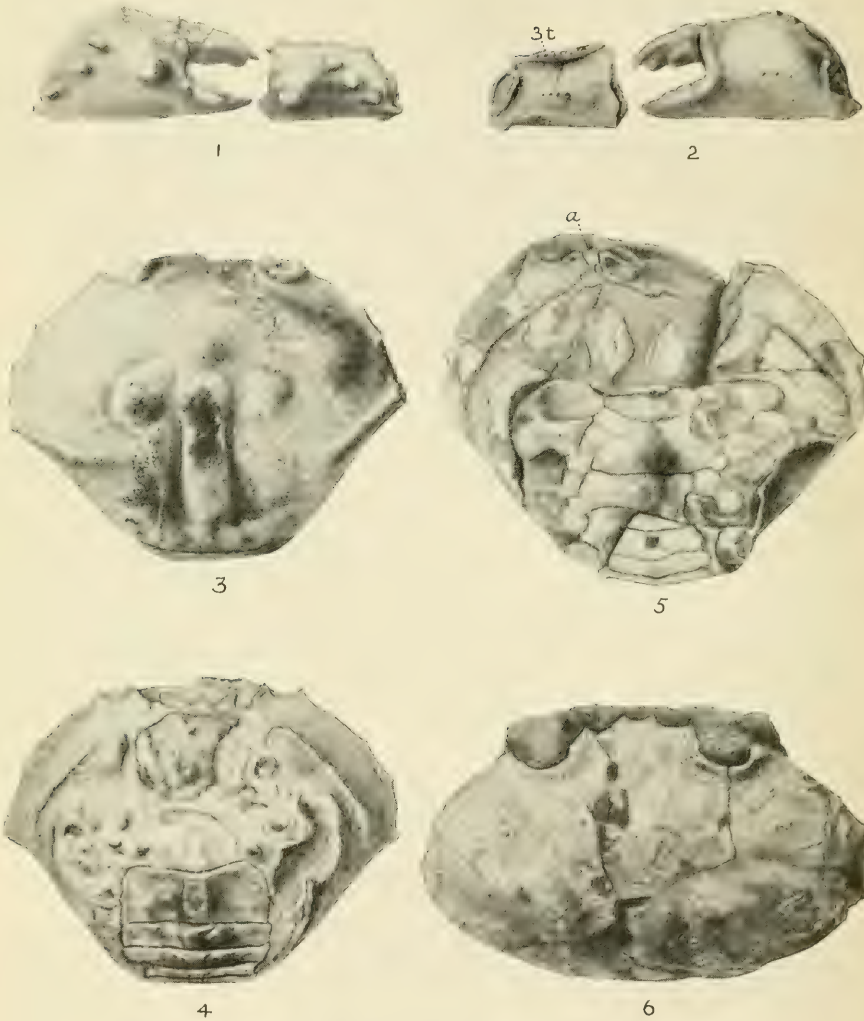
NOTOSCELES BOURNEI FROM THE EOCENE OF TEXAS

FOR EXPLANATION OF PLATE SEE PAGE 6



HARPACTOCARCINUS AMERICANUS FROM THE EOCENE OF TEXAS

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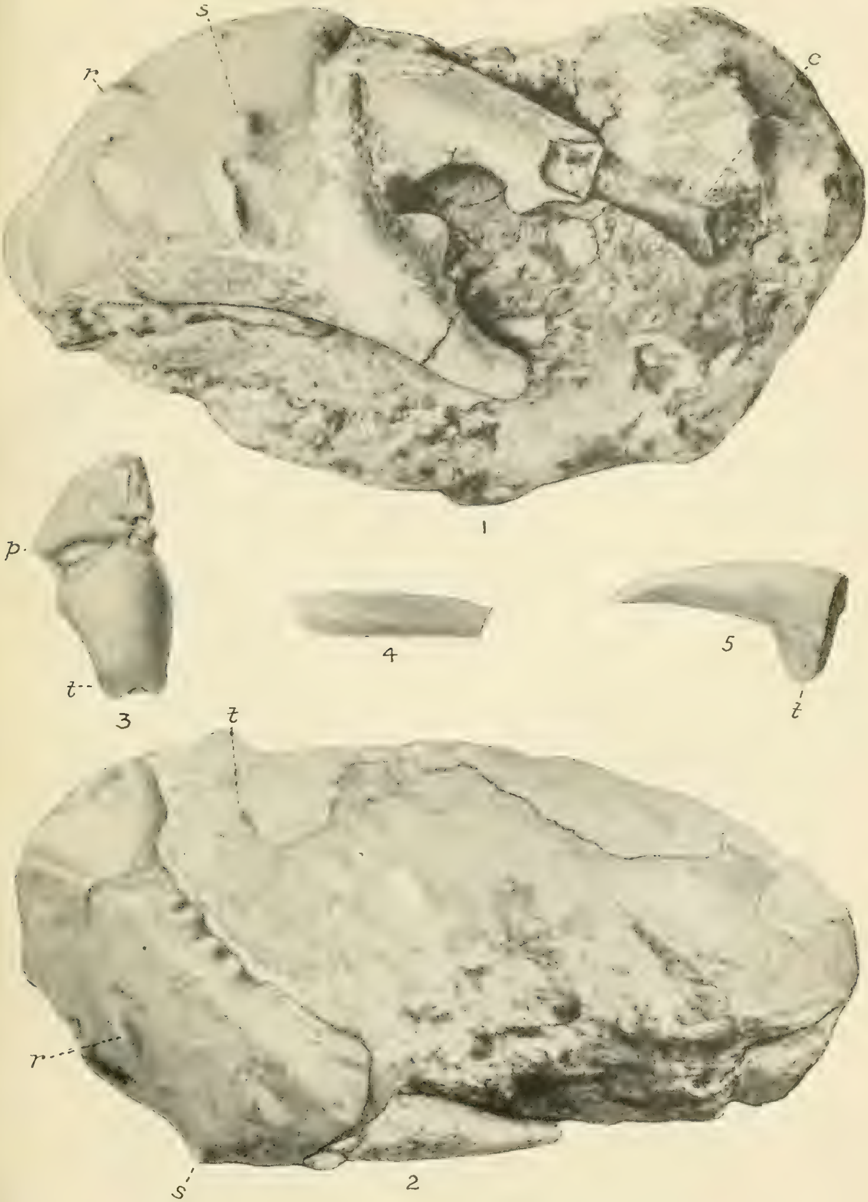

HARPACTOCARCINUS AMERICANUS FROM THE EOCENE OF TEXAS

FOR EXPLANATION OF PLATE SEE PAGE 6

A NEW FOSSIL REPTILE FROM THE TRIASSIC OF NEW JERSEY

By Charles W. Gilmore,
Curator of Vertebrate Paleontology, United States National Museum

INTRODUCTION

Through the generosity of Dr. C. N. Fenner of the Geophysical Laboratory, Carnegie Institution of Washington, the United States National Museum has come into possession of a fossil specimen of considerable scientific interest. Found in the Upper Triassic of New Jersey, this specimen is important as adding one more form to the meagerly known fauna of that geological period.

Under date of October 19, 1926, Doctor Fenner wrote me regarding the discovery of this specimen as follows:

It was found on or about September 10, 1926, by Herbert R. Fenner, 64 Broad Street, Clifton, at the intersection of the street with the tracks of the Delaware, Lackawanna, and Western Railroad. An excavation was being made there to change the grade of the street and carry it under the railroad tracks and the specimen had evidently been turned up in these operations. It was found as a loose slab. Search was made in the vicinity for the missing portions of the skeleton, but they were not found.

While I was at my brother's home last summer I visited the excavation a number of times and took note of the character of the strata. They consisted of the usual irregularly bedded alternations of reddish brown sandstone and shale that are characteristic of the Triassic of this region. There are occasional thin beds or strings of pebbles. Frequently the dividing surfaces between sandy layers were smooth, almost glossy, films of shale, such as might be left by the drying up of a pool of muddy water and very pretty rill markings were common, but no mud cracks or ripple marks. The smooth films of shale carried many small circular markings, perhaps bubble rings. There were also numerous little oval lumps of which the structure was too poorly preserved for any definite conclusion, but they vaguely suggested replacements of vegetable growths, such as cones or collections of short, acicular leaves.

The locality is about 0.3 mile to the east of the First Watchung trap ridge, and the gentle westerly dip would make the stratigraphic position about 400 feet below the base of the sheet, if there are no intervening faults. As you doubtless know, the Triassic of this region has been supposed to be entirely Upper Triassic.

At first glance the specimen gives the impression of being in an excellent state of preservation, but this idea is soon dispelled when

its study is begun. Those details of structure so essential for reaching a satisfactory decision as to affinities and relationships are largely wanting, and for that reason its classification within the order Reptilia remains much in doubt. However, it seems to represent an undescribed genus and species for which the name *Hypsognathus fenneri* is proposed, the specific name being in honor of Mr. Herbert R. Fenner, who found the type specimen. The illustrations were made by Mr. Sydney Prentice, draughtsman of the Carnegie Museum, Pittsburgh.

DESCRIPTION OF SPECIMEN

HYPSOGNATHUS, new genus

The characters of this genus are included in the following description of the type and only species:

HYPSOGNATHUS FENNERI, new species

Type.—Cat. No. 11,643, U.S.N.M. Consists of bone impressions of much of the axial skeleton anterior to the pelvic region.

Type locality.—Clifton, Passaic County, New Jersey.

Geological horizon.—Brunswick shale, Upper Triassic.

When received the specimen was imbedded in a single block of sandstone, the ventral side downward (see pl. 1) and, with the exception of some disarrangement of the neck vertebrae, the remaining parts of the axial skeleton more or less articulated. The posterior vertebral column, from a point in front of the sacrum, is missing, having been inclosed in another slab of rock which was not recovered. Likewise, the skull and upper parts of the vertebrae and ribs were held in the block of sandstone that split off the top of the specimen and for which unsuccessful search was made by Mr. Fenner. The lower jaws occupy their proper relative position in front of the vertebral column, and the ribs of both right and left sides are spread out in sequential order on either side of the line of vertebrae. Of the appendicular skeleton only the proximal end of a humerus and portions of one foot are recognized; the latter, from its position in relation to the skeleton is regarded as being the left manus.

Unfortunately, the soft chalky nature of the fossil bone did not permit developing the skeleton along the usual lines by freeing it from the matrix, and it was only after some experimentation that it was decided to remove the bones so as to leave their natural molds in the rock. (Pl. 2.)

Casts were then made of these impressions, thus securing accurate replicas of many of the actual bones. For purposes of study and description these casts were found to serve almost as well as the originals.

Skull and lower jaws.—The skull is entirely missing except for the articular ends of the quadrate bones which remained in an articulated position in relation to the lower jaw. This fact leads to the conclusion that the skull was originally present. The impression left by the removal of the left quadrate shows the articular end to have been bi-lobed. Measured across the quadrates the skull had a greatest width of 48.5 millimeters and from the anterior end of the rami to the center of the articular end of the quadrate it measures 42.5 millimeters, which allows the inference that the length and width of the skull were about equal.

The impressions left by the mandibles show them to lie in perfect relation to each other. They are broadly separated behind, and in front turn strongly inward to form a relatively wide, broadly rounded anterior end. The two rami meet in a strong sutural symphysis in which apparently the splenial bones did not participate. The striking characteristics of the mandible are the great depth of the prearticular portion and the transversely swollen character of the median portion of the jaws which enclosed the large Meckelian orifice. The postarticular processes are relatively short, thin dorsoventrally but widened transversely, especially on the outer border where a thin shelf of bone is developed that becomes gradually wider in an anterior direction, reaching its maximum width slightly forward of the cotylus of the jaw. This feature is clearly shown in Figure 1, a sketch made from a cast of the impression left in the rock.

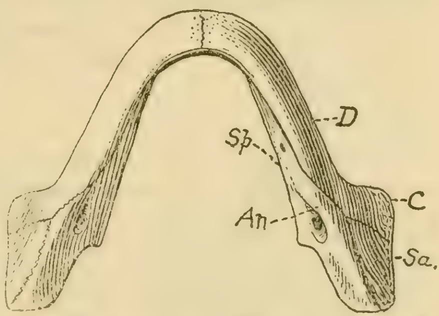

FIG. 1.—HYPSOGNATHUS FENNERI, NEW SPECIES. TYPE, CAT. NO. 11643, U.S.N.M. NATURAL SIZE. LOWER JAWS, INFERIOR VIEW. DRAWN FROM A CAST MADE FROM THE NATURAL MOLD IN THE ROCK. *An*, ANGULAR; *C*, CORONOID; *D*, DENTARY; *Sa*. SURANGULAR; *Sp*. SPLENIAL

Viewed externally the angular is plainly visible as a triangular area interposed between the lower posterior end of the dentary and the lower anterior end of the surangular. The suture separating the angular from the surangular appears to pass backward nearly to the extremity of the jaw. The surangular is relatively short, its anterior extremity being about opposite the middle of the coronoid process. The dentary as usual forms the great part of the ramus and except for the dentigerous border its mold is completely preserved. Although much of the bony matter of the dentaries was present when the specimen was received, nowhere did I find evidence of tooth roots or the presence of alveoli. This would seem to indicate that if teeth were present they were not held in distinct sockets, and this

fact allows the suggestion that the dentation may have been acrodont in character.

None of the sutures on the internal side of the jaws can be detected, rendering it impossible to differentiate the elements. Meckel's groove is prominently developed and leads back to the enlarged cavity in the swollen part of the jaw. It would seem that the forward part of this groove was open and that it was not covered by the splenial as in many reptiles. There seems to have been a small subcircular internal mandibular foramen at a point immediately opposite the coronoid section of the jaw. (See fig. 1.) A slight indentation immediately forward of the midlength of the ramus on the inner side strongly suggests the presence of a second but smaller foramen.

The unusual height of the mandible as a whole, its relatively short surangular, receding chin, and transversely swollen portion posterior to the middle are all features found in the jaw of the cotylosaurian reptile *Diadectes*.

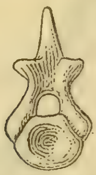

FIG. 2.—HYPSOGNATHUS FENNERI, NEW SPECIES. TYPE, CAT. No. 11643, U.S.N.M. ANTERIOR (1) DORSAL VERTEBRA. VIEWED FROM THE ANTERIOR END. NATURAL SIZE. DRAWN FROM A CAST MADE FROM THE NATURAL MOLD IN THE ROCK

Measurements

	Millimeters
Greatest length of mandible	46.5
Greatest width across center of symphysis	14.5
Greatest width across posterior ends of rami	48.5
Greatest depth of mandible at center	+12.5
Greatest width of postcornoidal part	13.0
Greatest width at center of ramus	7.3

Vertebrae.—Evidence is found showing the presence of at least 17 presacral vertebrae, but none is sufficiently well preserved to show the complete details of structure. Those immediately posterior to the lower jaws are widely scattered, but the remaining parts of the vertebral column were in articulated series, except for a short gap near the posterior end of the slab.

The centra are deeply amphicoelous and may have been notochoidal, though there is lack of positive evidence of this last suggestion. Neither do I find any evidence of the presence of intercentra. The zygapophyses are of good size and have the articulating planes horizontal as in *Seymouria* and *Telerpeton*. The mold of a vertebra lying on its posterior face, immediately posterior to the right ramus (pl. 3) serves to illustrate the great conical concavity of the centra. Furthermore it shows the relatively large size of the neural canal, the high arch, and the general heaviness of the vertebra as a whole as shown in Figure 2. From its position in relation to the rest of the skeleton I am led to the conclusion that it pertains either to the posterior cervical or the anterior dorsal region.

For the most part the dorsal vertebrae protruded into the overlying block of sandstone which was split off and lost, and hence little knowledge is to be had of the upper portions of the remaining dorsal vertebrae. These seem to have had broad centra with slightly concave sides with a slight median keel developed on the ventral side. Five articulated centra in the mid-presacral region have a combined length of 44 mm. Single vertebra vary from 7½ to 8 mm. in length. These measurements indicate an animal approaching the size of *Koiloskiosaurus*, a colytosaurian from the Triassic of Germany near Coburg, described by Huene.[1]

Telerpeton from the Triassic of Eligin, Scotland, has 24 presacral vertebrae in the complete series, and from the fragmentary evidence at hand it would seem that the specimen now before me may have had an equal number of vertebrae in the complete presacral series.

Ribs.—Impressions of 14 ribs of the left side and 11 of the right side are present. While only a few are preserved in their entirety, they show a gradual lengthening from the neck to the middle of the dorsal region, posterior to which they become progressively shorter and more slender. The longest rib measures 53 mm. from end to end. All of the ribs having a complete proximal end may be called single headed, though in reality both capitulum and tuberculum are probably present though connected. Williston[2] has suggested the term *holocephalous* for this type of rib articulation. He also points out that this form of articulation is almost invariable among the Cotylosauria, occurring occasionally in the Theromorpha and in the living *Sphenodon*. Those ribs that remain in articulated position, and there are at least eight of them, have their heads lying opposite the sides of their respective centra, a fact that seems to indicate their articulation to have been with transverse processes on the side of the vertebrae and not intercentral.

Pectoral girdle.—Two deep, slot-like impressions lying on either side of the vertebral column and in front of the longer ribs (fig. 3*S*), a position entirely in accord with the relative position of the pectoral girdle, are doubtfully regarded as having been made by the blade portions of the scapulae. The one point opposed to such a conclusion is the fact that the greatest diameter of these impressions lies transverse to the vertebral series, whereas, in the properly articulated skeleton the longer diameter of these bones would be more or less parallel with the backbone. Further development might disclose the true nature of these molds but this course was deemed inadvisable inasmuch as surrounding impressions would be destroyed. If these do represent the pectoral bones, and if they occupy their proper position in relation to the lower jaws, it would be evidence

[1] Huene, F. von, Die Cotylosauria der Trias, Palaeontographica, vol. 59, 1919, p. 75.
[2] Williston, S. W., Osteology of the Reptiles, 1926, p. 113.

opposed to cotylosaurian affinities, as Williston states that "the pectoral girdle [in the Cotylosauria] is almost invariably found lying immediately back of the skull, the front end of the interclavicle, indeed, between the angle of the jaws." If this is true, I would favor an assignment to the Theromorpha on account of the longer neck.

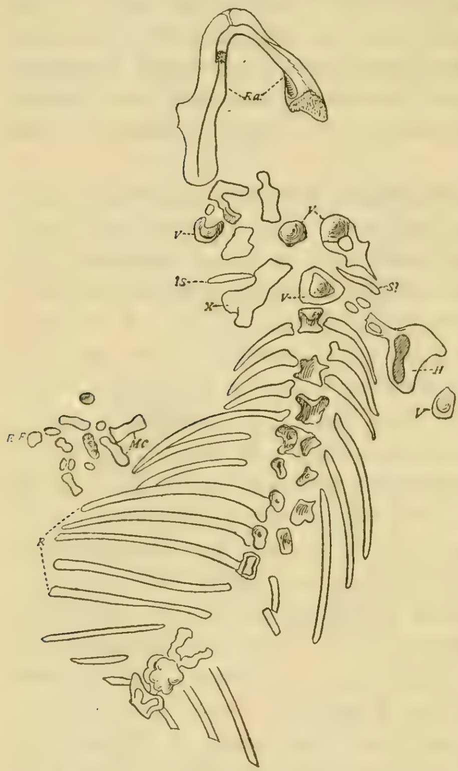

FIG. 3.—HYPSOGNATHUS FENNERI, NEW SPECIES. TYPE, CAT. NO. 11643, U.S.N.M. OUTLINE OF SKELETON AS FOUND IN THE ROCK. ABOUT ONE-HALF NATURAL SIZE. *F. F.*, ELEMENTS OF LEFT FORE FOOT; *H*, PROXIMAL END OF HUMERUS; *mc*, METACARPALS; *R*, RIBS; *Ra*, RAMI; *S*, SCAPULAE; *V*, VERTEBRAE; *X*, UNIDENTIFIED BONE

Fore foot.—The natural molds of a group of small disarticulated bones on the left side of the skeleton and clear of the rib ends are regarded as being the elements of the left fore foot. (See fig. 3, *F. F.*) Two of the longest of these are thought to be metacarpal bones (see fig. 3, *mc.*); the longest has a greatest length of 10 mm., the other 9.4 mm. The molds of some smaller bones lying anterior to the metacarpals may represent carpal bones, but I have been unable to identify any of them. Obscure indications show the presence of phalangeal elements, including one slightly curved, pointed, ungual phalanx that has a greatest length of 5.5 mm. The preservation is such that I have been unable to positively identify the proper articulated relationships of any of these scattered bones. One of the metacarpal bones has a wide shaft with expanded extremities, while the longest has a shaft that is subcircular in cross-section.

DISCUSSION OF RELATIONSHIPS

In the absence of the skull and other diagnostic parts of the skeleton no satisfactory conclusion has been reached concerning the family and other relationships of the specimen under consideration. The presence of holocephalous ribs, deeply amphicoelous vertebrae, dentary of unusual height with receding chin, and mandible greatly

swollen transversely are a combination of characters in which *Hypsognathus* seems to show cotylosaurian affinities. On the other hand, as Dr. E. C. Case has pointed out to me, the relatively narrow and high neural arches of the vertebrae seem to be opposed to such a relationship. After an examination of a cast of the type specimen he says:

> The neural arches of all cotylosaurs are low and very broad; this is high. I know of no exception to this rule, low broad neural arches in the Cotylosauria. Broili's *Solenodonsaurus* is reported by him to have narrow neural arches, but others who have seen the specimen say this is obviously due to compression.

Perusal of the literature shows the above generalizations to be correct, though it seems to me they do not fully apply to certain of the cotylosaurians from the European Triassic described by Huene.[3] Reference is made to the vertebrae of *Koiloskiosaurus*, which appears to have a neural arch equally as high and narrow as the vertebrae of *Hypsognathus*. The spinous processes are likewise of nearly equal height. Furthermore, the lower jaw of *Kioloskiosaurus* in its considerable height with receding anterior end, and rapidly reducing height of the end posterior to the coronoid processes are features held in common with the mandible of *Hypsognathus*. If correct in my identification of a portion of a limb bone as being the proximal end of the humerus, this end is shown to be much expanded as in other cotylosaurian reptiles. The few metapodials preserved are also in accord with such relationships. While the evidence thus briefly reviewed is insufficient to certainly determine the affinities of the present specimen to lie within the Cotylosauria, it nevertheless strongly suggests such relationship.

Of the few known elements of the Upper Triassic fauna of North America *Stegomosuchus longipes* (Emerson and Loomis) is the only form that need be compared with the present specimen. The larger size of *Hypsognathus*, the absence of dermal armor, the deeper heavier mandible, and the short and stout metapodials are a group of features that seem quite sufficient to show its distinctness from that species. In size and general proportions it closely approximates *Koiloskiosaurus coburgiensis* Huene, and in general appearance it would probably not be greatly unlike Huene's restoration of that animal.

On account of the several resemblances to certain Triassic cotylosaurians discussed above I propose to provisionally refer *Hypsognathus fenneri* to the Order Cotylosauria in the hope that the discovery of better preserved and more diagnostic specimens will either confirm this tentative reference or reveal its true relationships.

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[3] Die Cotylosauria der Trias, Palaeontolographica, vol. 59, 1912, pp. 69 to 102.

EXPLANATION OF PLATES

Plate 1

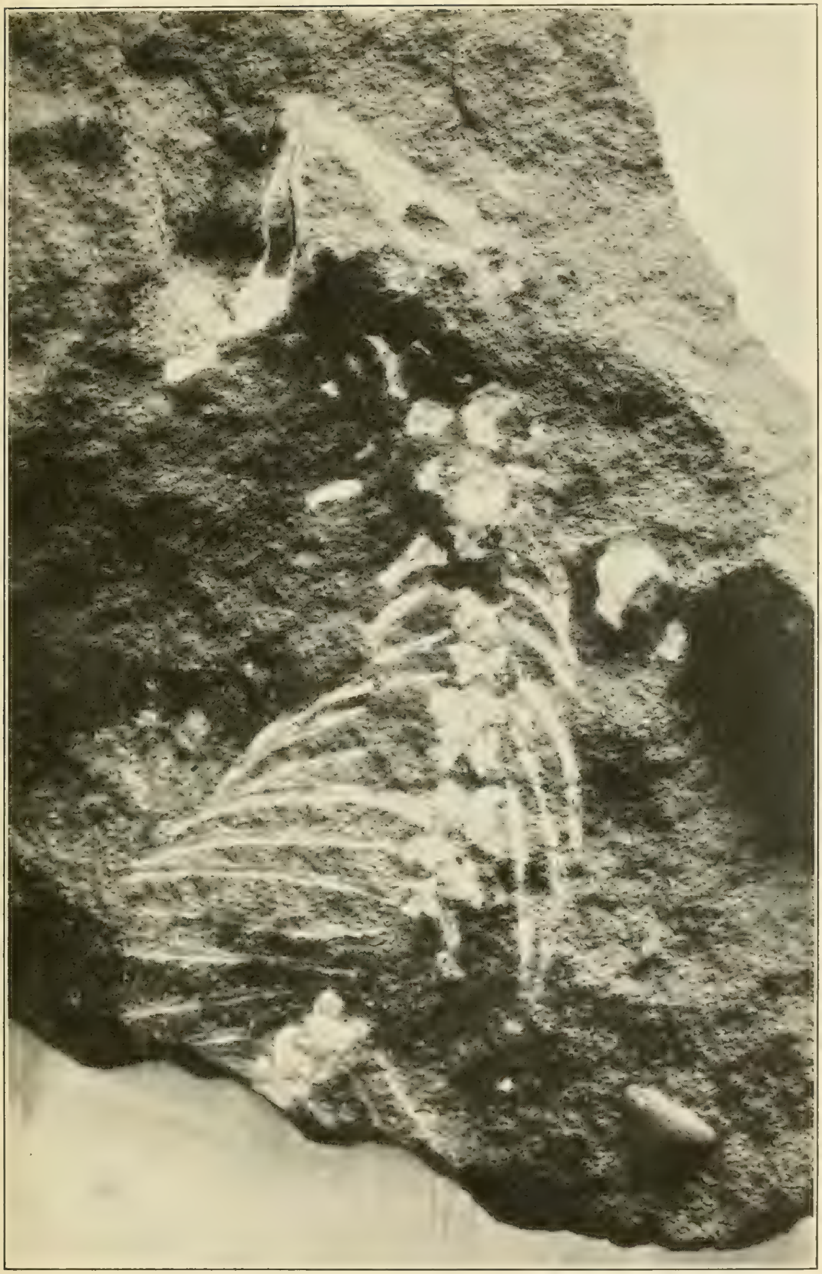
Hypsognathus fenneri, new species. Type, Cat. No. 11643, U.S.N.M. About three-fourths natural size. Shows the condition of the specimen as received.

Plate 2

Hypsognathus fenneri, new species. Type, Cat. No. 11643, U.S.N.M. About three-fourths natural size. Shows the natural molds of the various bones of the specimen after the removal of the chalky osseous matter.

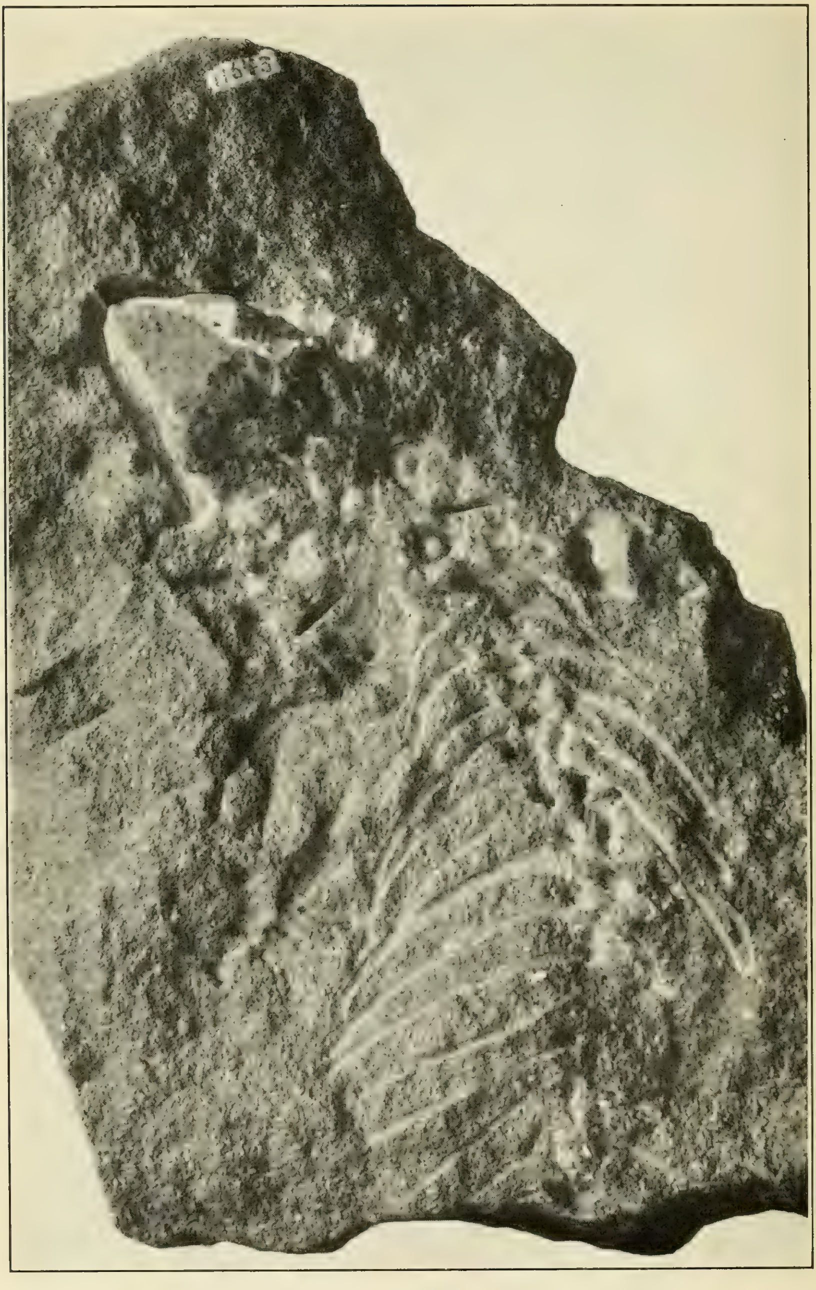
Plate 3

Hypsognathus fenneri, new species. Type, Cat. No. 11643, U.S.N.M. More than three-fourths natural size. Wash drawing which more clearly depicts the form and relationships of the preserved skeletal parts.



HYPSOGNATHUS FENNERI, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 8



HYPSOGNATHUS FENNERI, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 8

HYPSOGNATHUS FENNERI, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 8

A REVISION OF THE AMERICAN PARASITIC FLIES BELONGING TO THE GENUS BELVOSIA

By J. M. Aldrich,

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The present paper contains descriptions of 36 species and 2 varieties of flies belonging to the genus *Belvosia*, of which 19 species and 2 varieties are new to science.

It is based on the material in the United States National Museum, together with that in the American Museum of Natural History, the University of Kansas, the Vienna Natural History Museum, and that in the private collections of C. W. Johnson, Prof. Jas. S. Hine, and Prof. A. L. Melander. Mr. C. H. Curran, in charge of the Diptera of the Canadian National Collection, kindly furnished paratypes of two of his species that I had not seen. I should especially mention the generosity of Dr. F. Maidl, of the Vienna museum, who sent all the material in that museum which had been studied by Messrs. Brauer and Bergenstamm.

Genus BELVOSIA Robineau-Desvoidy

Belvosia Robineau-Desvoidy, Myodaires, 1830, p. 103.—Osten Sacken, Catalogue N. A. Diptera, 1878, p. 153.—Van der Wulp, Biologia, Dipt., vol. 2, 1888, p. 29.—Williston, Insect Life, vol. 5, 1893, p. 238.—Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 6, 1893, p. 238.—Adams, in Williston's Manual, 1908, pp. 372, 373.—Townsend, Taxonomy Musc. Flies, 1908, p. 103.—Curran, Bull. Brooklyn Ent. Soc., vol. 22, 1927, p. 150.

Latreillia Robineau-Desvoidy, Myodaires, 1830, p. 104.—Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 4, 1889, p. 97; pt. 6, 1893, pp. 123, 204.

Willistonia Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 4, 1889, p. 97; pt. 5, 1891, pp. 349, 403; pt. 6, 1893, p. 123.—Townsend, Muscoid Flies, 1908, p. 103.

Latreillimyia Townsend, Muscoid Flies, 1908, p. 105.

Goniomima Townsend, Muscoid Flies, 1908, p. 105.

Triachora Townsend, Muscoid Flies, 1908, p. 105.

Belvosiomima Townsend, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 413.

Belvosiopsis Townsend, Revista Museu Paulista, vol. 15, 1926, p. 248.

The sole original species of *Belvosia* was *bicincta*, new, from Carolina and the Antilles. *Latreillia* contained two American species, *Musca*

bifasciata Fabricius and *unifasciata*, new, as well as eight from the Old World. Brauer and Bergenstamm apparently indicated *bifasciata* as type, and this species was definitely designated by Coquillett,[1] *Latreillia* being preoccupied, *Latreillimyia* was proposed to replace it, taking the same genotype. *Willistonia* had but one originally included species, *Musca esuriens* Fabricius. *Goniomima* had but one originally included species, *Belvosia luteola* Coquillett, which was also designated as type. *Triachora* had but one originally included species, *Latreillia unifasciata* Robineau-Desvoidy, which was also designated as type. *Belvosiomima* had but one originally included species, *fosteri*, new, which was also designated as type. *Belvosiopsis* was proposed for the single species *brasiliensis*, new, also designated as type; this I place as a synonym of *Belvosia leucopyga* Van der Wulp.

Thus it appears that there are seven different generic names to consider in this group, each based on a different type species. I have studied with care all the type species, with reference not only to the generic characters originally mentioned but to others which might have this value. In nearly 40 species, represented by about 700 specimens, there is such a complete blending of the characters that I can not find one which will divide the mass in a consistent manner; nor do I see how a satisfactory division can be made into half a dozen or more genera. The genera have all been made on too few species, and the describers attribute higher value to length of antennae, distance of vibrissae from oral margin, etc., than I can find. It is true that certain species when compared with each other seem generically distinct in the absence of others which connect them; and I thought for some time that two or three genera could be maintained. The genitalia are very homogeneous and the reproductive habits are the same throughout, as far as known.

Williston, in his 1893 paper, discussed the characters in an able manner, and showed that those used by Brauer and Bergenstamm were not of generic value. He saw that if they were even specific there must be many more species than were then supposed, but left the question of specific limits for future study.

The generic characters of *Belvosia* as here taken are as follows: The head is uncommonly wide, but short, the anterior surface flattened; length at vibrissae not much less than at antennae; front broad in both sexes; eyes bare; ocellar bristles absent, frontals varying widely in the sexes and in different species, from three irregular rows to one nearly regular; proclinate orbitals present in all females, and in the males of *luteola*, *unifasciata*, *fosteri*, *ochriventris*, *slossonae*, and *equinoctialis*; vibrissae considerably above the oral margin, the distance in general about the same as the length of the second antennal joint; parafacials broad, bare; facial ridges always bristly to nearly one-half

[1] Proc. U. S. Nat. Mus., vol. 37, 1910, p. 558.

their height, often much more; penultimate joint of arista distinct and a little elongated, not geniculate; arista usually thickened for most of its length, sometimes flattened nearly to the tip; cheeks uniformly a little less than half the eye height; palpi and proboscis normal. Thorax with usually four sternopleurals (from three to six or more); scutellum with a row of long, depressed laterals, from four to six pairs, and sometimes a smaller, suberect, spiny apical pair, which are highly variable and poorly developed as a rule. The number of laterals is somewhat variable also and of slight importance in separating the species. Abdomen generally broad, never with discals, the genitalia of the male rather small and showing but feeble specific characters; they are of a common type, consisting of inner and outer pairs of thick, short forceps, the penis elbowed and ending in a vase-like opening. The wings are very uniform, third vein with only a few bristles at base, apical cell open far before the tip. Legs with good characters in the male pulvilli, which are usually enlarged, and with the bristles of the outer side of the hind tibia variously developed but subject to sexual variation in the species.

The characters which seem most useful are the color of the small hairs below the lowest frontals, and the extent of the pale pollen on the third and fourth abdominal segments; other details of the pollen of the abdomen furnish many minor points, and these seem to be very constant in well-preserved specimens. I have omitted the thoracic chaetotaxy almost entirely, as it is too uniform to give any specific characters except in rare cases. A delicate character of some importance in males is the shape of the upper curve of the compound eye; where this is more broadly rounded the front does not begin to widen for a short distance from the vertex; but in some species (*bifasciata*, for example) the eye is narrow and almost pointed above, so that the front widens immediately from the vertex. The pollen of the parafrontals gives a number of good specific characters, especially in males. The frontal bristles I view with suspicion, as they seem highly variable. The length of the third antennal joint as compared with the second has a considerable value, although some variation must be expected. The pulvilli of the males offer several degrees of development, and seem constant for the sex and species.

The nearest related genus is perhaps *Atacta* Schiner, in which the thoracic and abdominal structure are much like *unifasciata;* it, however, has a narrow front in the male, very flat facial ridges, frontal bristles reduced, and the ocellars are present.

The reproductive habits are the same in all species as far as known; the females lay large numbers of minute eggs on foliage which are swallowed by caterpillars along with the leaf which they are eating. This is the second group of Pantel, which includes *Gonia*, *Spallanzania*, etc.

The genus is known only from the New World.

KEY TO SPECIES OF BELVOSIA

1. Fourth abdominal segment wholly shining black, the usual pollen absent__2.
   Fourth abdominal segment black, with a conspicuous large spot of pale pollen above, which does not extend down the sides nor reach the tip; abdomen elsewhere black (Argentina, Brazil)______weyenberghiana Van der Wulp.
   Fourth abdominal segment densely pollinose on basal half or more, the pollen extending down the sides and ranging in color from almost white to reddish orange____3.
2. Second abdominal segment with two or three pairs of spinelike median marginal bristles; large, spinose, robust species (Bolivia)__manni, new species.
   Second abdominal segment with a continuous marginal row of about 18 bristles; medium-sized, less spinose species (south Brazil).
   australis, new species.
3. Both third and fourth abdominal segments with pollen of deep orange or reddish color____4.
   Pollen not alike on the two segments, or else paler, at most golden______5.
4. Pollen of head brown except facial ridges and a spot on parafacial, where it is silvery (San Domingo)______________________vanderwulpi Williston.
   Pollen of head silvery white (Jamaica)_____________ferruginosa Townsend.
5. The small hairs below lowest frontals are pale and delicate_____________6.
   These hairs are black and generally less delicate_____________________14.
6. Fourth abdominal segment wholly pale pollinose to apex_______________7.
   Fourth abdominal segment with the tip black, including bases of marginal bristles (south Florida)____________________________slossonae Coquillett.
7. Third and fourth segments of abdomen with broad, uninterrupted cross-bands of dense yellow pollen; basal abdominal segments black__________8.
   Third segment not strongly contrasting with second, the band if broad clearly interrupted; abdomen generaly more reddish or yellow in ground color ____9.
8. Third segment densely yellow pollinose to tip, like the fourth (United States)____________________________________semiflava, new species.
   Third segment black at tip (Mexico, Brazil)_________mexicana, new species.
9. Second abdominal segment shining translucent yellow, with median black stripe (Porto Rico, Peru)____________________________luteola Coquillett.
   Second abdominal segment with obvious pollen over most of its surface, or black in ground color____10.
10. Ground color of abdomen yellow (Mexico, Panama).
    ochriventris Van der Wulp.
    Ground color of abdomen black, sometimes tending toward reddish but not yellow____11.
11. Male without orbitals (*recticornis* Macquart)_________________________12.
    Male with orbitals____13.
12. Third antennal joint black (Mexico, Peru, Ecuador)___recticornis Macquart.
    Third antennal joint almost entirely red (Brazil).
    recticornis var. ruficornis, new.
13. Third antennal joint six times the second in the male, in the female three times; male pulvilli small (Paraguay, Brazil)__________fosteri Townsend.
    Third antennal joint hardly three times the second in the male, twice in the female; front pulvilli in male longer than last tarsal joint (Peru, Guatemala, Porto Rico)____________________________equinoctialis Townsend.
14. Fourth abdominal segment with dense yellow pollen to tip______________15.
    Fourth abdominal segment black at tip, including the bases of the marginal bristles____22.

15. Pollen of second and third abdominal segments gray, that of fourth deep golden, strongly contrasting (northern species)..........16.
Pollen of second and third abdominal segments velvet black, that of fourth pale golden (Brazil)..........wiedemanni, new species.
Pollen not as described..........17.
16. Thorax indistinctly striped, male with orbitals; front in both sexes translucent yellow, shining, not pollinose (eastern United States).
unifasciata Robineau-Desvoidy.
Thorax very distinctly striped; male without orbitals; front much darker (Virginia, Maryland)..........omissa, new species.
17. Large blackish species; male with large pulvilli..........18.
Moderate-sized species; male with small pulvilli except possible in *vittata*..........20.
18. Third abdominal segment wtih broad, deep yellow uninterrupted pollinose band matching the fourth and leaving only the apical quarter black (Mexico, Brazil)..........mexicana, new species.
Third segment not as described (compare *canalis* also)..........19.
19. Third abdominal segment with very narrow basal pollinose band; male with outer forceps brown, not swollen (Mexico, Costa Rica; *analis* of authors).
ciliata, new species.
Third abdominal segment with interrupted pollinose band covering basal half; male with outer forceps yellowish except at tip, distinctly swollen (South America, Panama, West Indies)..........ciliata var. formosa, new.
20. Thorax very distinctly striped; third antennal joint of male very long, seven or eight times the second (Paraguay)..........vittata, new species.
Thorax indistinctly striped; third antennal joint not so long..........21.
21. Third antennal joint red, hairs of cheeks pale yellow (Brazil).
frontalis, new species.
Third antennal joint black, hairs of cheeks blackish but delicate (Brazil).
elusa, new species.
22. Third abdominal segment with complete dense golden pollinose band covering all but the apical fourth or fifth, which is black..........23.
Third abdominal segment wholly golden pollinose to the apex on the sides, a narrow hind margin along the middle of the dorsum black (Alberta, Middle West)..........canadensis Curran.
Third abdominal segment with narrower or distinctly interrupted crossband..........27.
Third segment entirely black, the only pale pollen being on the fourth (Brazil, Venezuela)..........leucopyga Van der Wulp.
23. Cheeks with very thin pollen, the black ground color showing through; parafrontals shining black (Manitoba, Illinois, Kansas)..........splendens Curran.
Cheeks with dense white pollen..........24.
24. Front calypter blackened, frequently the hind one also; wings blackish; very large forms..........25.
Front calypter white or barely yellowish; wings brown; not so large..........26.
25. First and second abdominal segments with three pairs (rarely two) of median marginals; male with front pulvilli long, much longer than last tarsal joint. The largest species of all (United States, mostly northeast).
borealis, new species.
First and second abdominal segments with only a single pair each of median marginals; male with front pulvilli short, not equalling last tarsal joint (if with long pulvilli see *mexicana*) (United States, Guatemala).
bifasciata Fabricius.

26. Male with bright silvery parafrontals; antennae black, third joint in male three times the second; facial ridges of male strongly bristly (eastern United States) ---------- **argentifrons, new species.**
    Male with parafrontals generally with yellowish pollen, dull; antennae somewhat reddish, third joint in male twice the second; bristles of facial ridges not uncommonly strong (United States) ---------- **townsendi**, new species.
27. Third antennal joint only a little longer than second; vibrissae more than two-thirds the length of the third antennal joint above oral margin (widespread) ---------- **bicincta** Robineau-Desvoidy.
    Third joint usually more than twice the second, vibrissae never more than half the length of the third joint above the oral margin ---------- 28.
28. With only a single row of frontal bristles, not counting the orbitals in female ---------- 29.
    With at least a partial second row of frontals ---------- 30.
29. Third abdominal segment with only narrow trace of pollinose basal band, male with bright silvery parafrontals (Brazil) ---------- **potens** Wiedemann.
    Third abdominal segment with pale yellow basal crossband covering half of the segment (Salvador) ---------- **nigrifrons**, new species.
30. Second abdominal segment with two or three pairs of median marginals; robust, spiny species (Guatemala, Brazil) ---------- **lata**, new species.
    Second abdominal segment with only one pair of median marginals as usual ---------- 31.
31. Third abdominal segment with only a very narrow basal pollinose band, covering about one-sixth of its width (Brazil) ---------- **smithi**, new species.
    Third abdominal segment with interrupted band covering about one-half of its width, rarely a little less ---------- 32.
32. Hind coxae on inner side with two or three strikingly long, stout spines directed backward (Paraguay, Brazil, Cuba) ---------- **spinicoxa**, new species.
    Hind coxae with distinct but not striking bristles ---------- 33.
33. Hind tibia stout, with coarse, irregular bristles on outer side (Brazil). **esuriens** Fabricius.
    Hind tibia with a dense row of almost even cilia on outer side ---------- 34.
34. Second abdominal segment shining black, parafrontals in male dark plumbeous (Brazil, British Guiana) ---------- **williamsi**, new species.
    Second abdominal segment opaque black, parafrontals in male with dense yellowish pollen (Canal Zone, Brazil) ---------- **canalis**, new species.

BELVOSIA WEYENBERGHIANA Van der Wulp

Belvosia weyenberghiana Van der Wulp, Tijdsch. v. Ent., vol. 26, 1883, p. 26. pl. 1, fig. 16.

Male.—Front at vertex 0.34 of the head width, the sides nearly parallel for a short distance; face, parafacials, cheeks, and posterior orbits white pollinose. Parafrontals with much thinner pollen, dark and subshining over most of their area. Frontal bristles very irregular, hardly in three rows, more erect than in most of the species. The hairs of the upper parafacials are black; cheek nearly two-thirds the eye height, with black hairs, some quite bristly. Antennae blackish, the third joint quite short, one and a half times the second. Vibrissae about the length of the second antennal joint, above the oral margin; facial ridges with black bristles extending above the middle. Palpi yellow.

Thorax black, with gray pollen in front, becoming brown behind, decidedly so on the scutellum. Sternopleurals variable, from three to six.

Abdomen black subopaque, of uniform color, except on the fourth segment, which has a very striking spot of pale yellow pollen covering the whole upper surface except the apical fifth. This pollinose area bears no small hairs and ends abruptly at the sides. Second segment with 4 to 6 marginals.

Legs black. Front pulvilli elongated, nearly twice the last tarsal joint. Hind tibia with a row of nearly a dozen bristles of increasing size on the basal two-thirds, a few coarse hairs with these and extending to the tip.

Wings almost black, fourth vein rather strikingly curved backward at the bend, which is rounded. Calypters blackish.

Female.—Front 0.35 of the head width, widening from vertex. Front pulvilli small.

Length, 10 mm.

Redescribed from 1 male specimen collected at Sao Paulo, Brazil (Dr. A. Lutz), and 6 males and 10 females in the Vienna Museum, 12 of which are labeled "Beske, Brasilien"; 3 are "Natterer Brasil"; 1 simply "Brasilien." Three of these are added to the National Museum collection. The type was a male from Argentina.

BELVOSIA MANNI, new species

Female.—A large robust species without pale pollen on the abdomen. Front at vertex 0.38 of the head width, widening immediately from the level of the anterior ocellus. Parafrontals with thin plumbeous pollen, becoming shining in the middle region. Frontal stripes almost black, the frontal bristles in two irregular rows, besides three proclinate orbitals each side, the small hairs below the frontals are black. Parafacials and cheeks with almost white pollen, both very broad, the cheek fully one-half the eye height, with black hairs. Facial ridges with small bristles about halfway up. The vibrissae more than half the length of the third joint above the oral margin. Antennae black, the third joint less than twice the second and somewhat protuberant near the arista. Palpi dark yellow; beard white.

Thorax decidedly black, with thin gray pollen which changes to dark brown on the scutellum. Scutellum with six pairs of long bristles in the described specimen, without any smaller apical suberect pair.

Abdomen very broad, entirely black, rather dull, without distinct pollen. The first segment with three pairs of marginal bristles, the second with three on one side and two on the other, the third with a marginal row of about 14; the fourth with a row of about the same number situated at two-thirds of the length, a few smaller bristles on the extreme apex.

Legs black, claws and pulvilli yellow; hind tibia with six or eight suberect bristles on the outer side, just behind which are numerous sloping cilia.

Wings dark brown, bend of fourth vein rather close to margin, the distance about half of that between hind cross vein and bend. Both calypters blackish.

Length, 15.5 mm.

Described from one female collected at Ixiamas, Bolivia, in December, 1921, by Dr. W. M. Mann, while director of the Mulford Biological Exploration.

Type.—Female, Cat. No. 40474, U.S.N.M.

BELVOSIA AUSTRALIS, new species

Female.—Front 0.35 of the head width at level of the front ocellus, widening rapidly below; parafrontals with thin plumbeous pollen, having a blackish appearance in some directions but not actually shining. The frontal bristles mostly in a single row except three pairs of proclinate orbitals. The hairs below the frontals are rather numerous and distinctly black. Face, parafacial, and cheek shining white pollinose, almost silvery; vibrissae not so far above the mouth as in most species, the distance being somewhat less than the length of the second antennal joint; facial ridges bristly to the middle; antennae blackish, third joint one and a half times the second. Palpi yellow, rather large and swollen; beard white.

Thorax black with gray pollen, that of scutellum dark brown.

Abdomen wholly black, the last two segments rather shining, the first with two pairs of median marginals, the second with a complete marginal row of about 20, the third with a marginal row of 14, the fourth more shining black than in the preceding, with a submarginal row of smaller bristles, about 14 in number.

Legs black, claws and pulvilli yellow, the hind tibia with a rather even row of sloping small bristles or stout cilia, about 25 in number, one below the middle somewhat larger.

Wings dark brown; both calypters blackish.

Length, 11 mm.

Described from one female, Rio Grande do Sul, Brazil, from the collection of C. W. Johnson, to whom the specimen has been returned.

BELVOSIA VANDERWULPI Williston

Belvosia vanderwulpi Williston, Trans. Amer. Ent. Soc., vol. 13, 1886, p. 303.

Female (type).—Vertex 0.30 of head width. Head with brown pollen throughout except the facial ridges and an indefinite spot on the lower part of the parafacial; the facial ridges contrast strongly in color with the face, they being of a dull silvery or slightly plumbeous

color, which extends to the oral margin; frontal bristles in a single row, the lowest two or three extending almost transversely toward the eye. Antennae black, second joint more than one-half the third; arista missing. Palpi black. The parafacial hairs below the frontals are black and rather strongly developed; the hairs of the cheek are also black. The hair on the back of the head and the beard are rather dark brown in color, a very unusual mark.

Mesonotum damaged with glue so the pollen is spoiled. Sternopleural four on one side and three on the other. Calypters brown.

Abdomen uniformly black on the first and second segments; the third and fourth uniformly and densely covered with pollen of a peculiar deep reddish orange or burnt orange color, which extends to the tips of the segments including the rows of bristles. The color of this pollen is very characteristic and quite unlike the common forms.

Legs black.

Wings brown with a distinct yellowish tinge along the front part near the base and becoming subhyaline around the anal angle. Bend of fourth vein slightly oblique, its distance from the margin only a little less than from the cross vein. Third vein with two bristles at base.

Length, 13 mm.

Redescribed from the type specimen, now in the University of Kansas collection; it is from San Domingo, West Indies.

BELVOSIA FERRUGINOSA Townsend

Belvosia ferruginosa Townsend, Trans. Amer. Ent. Soc., vol. 22, 1895, p. 71.

The original description is as follows:

Length nearly 12 mm. Eyes green in life; front brownish red on each side, more or less silvery pollinose; frontal vitta soft brownish golden; facial depression, sides of face and cheeks, rich silvery white pollinose, cheeks hairv. Antennae dark brown, the third joint linear and nearly three times as long as second; arista brown; palpi brownish black, yellowish on tips; vertex somewhat yellowish; posterior orbits silvery white. Thorax and scutellum brownish red, the former thinly pollinos before, leaving the beginnings of four narrow vittae; posterior corners of mesoscutum yellowish, also a little yellowish behind humeri. Abdomen of a beautiful iron-rust yellow, in the first and second segments the yellow shade predominating, in the third and fourth the iron-rust shade; first segment brownish under scutellum; a median pair of macrochaetae on first and second, a marginal row on third and fourth segments. Legs soft blackish, pulvilli and claws yellow. Wings uniformly pale fuscous; tegulae same color.

Bath, Jamaica (E. M. Swainson); bred from a lepidopterous chrysalis; one male. A beautiful species. Type in coll. Townsend.

The type of this species appears to be lost, as it is not in the University of Kansas collection where the other early types of Townsend's are deposited. I have not found any specimens which I could identify as belonging to this species.

BELVOSIA SLOSSONAE Coquillett

Belvosia slossonae COQUILLETT, Proc. Acad. Nat. Sci. Phila., vol. 47, 1895, p. 312; Revis. Tachin., 1897, p. 84.

Male.—Front 0.37 to 0.41 of the head width at vertex, inner margins of eyes diverging only slightly, so that the front is nearly as wide as the face, rather prominent at the antennae. Parafrontals silvery on lower part, translucent brownish above except in diagonal view; frontal bristles in about three rows and there are in addition two pairs of proclinate orbital bristles as in female; face, parafacial, cheek, and posterior orbit silvery pollinose, the small hairs below the frontals are pale; cheek with pale hairs, and at the lower edge an irregular double row of black bristles. Palpi yellow; beard white. Antennae black, first two joints brown, third joint elongated and somewhat swollen at the origin of the arista, more than four times the length of the second joint. Arista thick and flattened, broad to the tip, which is bluntly rounded; its total length is about three-fourths of the third antennal joint. Vibrissae quite close to the oral margin, the distance being only half the length of the second antennal joint; facial ridges with stout bristles for more than two-thirds their height, almost up to the arista. There are some white hairs on the ridges outside of the bristles.

Thorax black, densely cinereous pollinose, with four indistinct blackish stripes; pleurae with some pale, delicate hairs mixed with darker and larger bristles; scutellum black, the margin slightly reddish.

Abdomen black, second segment with gray pollen, fading out near the middle in most angles, but in certain directions visible almost to the hind margin; third segment about the same, but with a more distinct black hind border; fourth segment with denser and slightly more yellowish pollen on the basal two-thirds, mixed with a considerable number of erect black hairs. None of the pollen of the abdomen is very deep yellow. First and second segments with one pair of median marginals, third and fourth with a marginal row.

Wings brown, more yellow basally; both calypters white, contrasting with the wing.

Legs black, front pulvilli nearly as long as last two tarsal joints; hind tibia with a sparse, suberect row of about 13 bristles, the largest just below the middle.

Female.—Front at vertex 0.38 to 0.41 of the head width; front not so brown as in the male; third antennal joint shorter and second longer, so that the third is hardly more than twice the second; the facial ridges are much less bristly than in the male.

Length, 9–12 mm.

Described from a series of 5 males and 13 females, collected by C. H. T. Townsend at Miami, Fla., October 26–November 14; 2

of these specimens were compared by Prof. A. L. Melander with the single female type of *slossonae*, formerly in the collection of Mrs. Annie Trumbull Slosson, but now in that of the American Museum of Natural History. It was collected by Mrs. Slosson at Charlotte Harbor, Fla.

BELVOSIA SEMIFLAVA, new species

Male.—Front at vertex 0.40 of the head width, widening only a little for a short distance. Frontal bristles in three irregular rows, the parafrontals with white pollen becoming thinner and more gray above, the upper part black and subshining; face, parafacials, cheeks, and posterior orbits silvery white. Face rather narrow. The hairs below the frontal bristles are pale with a yellow tinge. Cheek almost half the eye height, with pale hairs. Antennae nearly black, basal joint somewhat paler, the third joint a little more than twice the second. Vibrissae rather high above the mouth, facial ridges with half a dozen small bristles reaching about halfway up their length; palpi rather dark yellow, in some specimens brown. Beard white.

Thorax black, not much pollinose except in front; scutellum more brownish.

Abdomen deep black on first two segments, not very shining, the remaining two entirely covered with deep yellow pollen. First and second segments with a single pair of median marginals, third and fourth with marginal rows of about 10.

Legs black; front pulvilli elongated, but scarcely equal to the last two tarsal joints. Hind tibia with suberect row of bristles on outer hind side, one larger below middle.

Wings brown, except toward base; calypters decidedly brown.

Female.—Front at vertex 0.40 (in two) of the head width; third antennal joint twice the second.

Length, 11–13 mm.

Described from 25 specimens of both sexes. The type and allotype are from Rio Ruidoso, White Mountains, N. Mex., collected July 19, on flowers of *Rhus glabra* (Townsend); 15 specimens from Kansas (Bourbon, Franklin, Linn, and Cheyenne Counties; R. H. Beamer, Williams), received from University of Kansas; 1, Agricultural College, Miss. (Wheeler); 3, Clemson College, S. C. (Conradi); 1, Oak Grove, Va. (Townsend); and 3 from the Kansas collection labeled "W. T." in not very legible writing. I take these labels to be in Williston's handwriting and to mean Washington Territory, but as the species is common in Kansas and not otherwise known from the Northwest I fear a mistake in labeling has occurred.

Type.—Male, Cat. No. 40467, U.S.N.M.

BELVOSIA MEXICANA, new species

Male.—Front at vertex rather broad, 0.37 of head width in two specimens, widening almost immediately. Parafrontals gray pollinose

anteriorly, subshining near the vertex, the black color showing through on most of their surface. Frontals in three irregular rows. Face, parafacial, cheek, and orbit white pollinose with satiny reflection. The hairs below the lowest frontals are black, cheek with fine blackish hair. Antennae reddish brown on basal joints; the third joint black, a little more than twice as long as the second. Vibrissae considerably above the oral margin, the distance being about equal to the second antennal joint. Facial ridges bristly almost to the arista. Palpi yellow; beard white.

Thorax black with thin pollen anteriorly, posterior part and scutellum brown.

Abdomen black on the two basal joints, the third with broad golden yellow band covering all but the apical fourth; fourth entirely golden pollinose; first and second segments each having one pair of median marginal bristles; third and fourth with a marginal row.

Legs black, front pulvilli elongated, as long as last two tarsal joints. Hind tibia with numerous large, irregular bristles on outer side.

Wings and calypters dark brown.

Female.—Front at vertex 0.40 of the head width.

Length, 13.5–14 mm.

Described from two males and one female. The type is a male from Federal District, Mexico (E. G. Smyth), the other male is labeled simply "Mexico," while the female was collected at Campinas, Brazil (F. X. Williams), 1924.

Type.—Male, Cat. No. 40482, U.S.N.M.

BELVOSIA LUTEOLA Coquillett

Belvosia luteola Coquillett, Proc. U. S. Nat. Mus., vol. 22, 1900, p. 253.
Goniomima luteola Townsend, Taxonomy of Muscoid Flies, 1908, p. 105.

Male.—Front 0.40–0.41 of the head width at vertex, not widening very rapidly; frontal bristles in two or three sparse rows, quite irregular; two pairs of proclinate orbitals. Parafrontals yellowish pollinose on lowest part, the remainder translucent and subshining; face, parafacials, cheeks, and posterior orbits silvery on light ground color. Hairs of upper parafacial and cheek white. Antennae with basal joints reddish brown, third joint black, elongated, four times the second. Arista flattened nearly to the apex, which is acute. Vibrissae not very far above the oral margin, the distance equaling the length of the second antennal joint; facial ridges with about six bristles, not quite reaching the level of the arista; several small white hairs outside the bristles. Palpi yellow; beard white.

Thorax black with rather dense yellow pollen, the usual stripes narrow and distinct; sternopleurals three or four; scutellum dark yellow in ground color.

Abdomen subtranslucent yellow in ground color, except a median dorsal stripe which is black. Second segment when viewed from behind covered with yellow pollen at the base, which thins out posteriorly; the third segment has a much denser coating of yellow pollen, which, however, is not distinctly visible in some angles. The hind margins of the second and third segments are shining in all angles; fourth segment smaller than in most species, densely covered with yellow pollen to the apex. First and second segments with single pair of median marginals, those on the first quite small; third and fourth segments with a marginal row of about eight. Genitalia a little larger in proportion than in some of the species, outer forceps very slender and straight, blunt at tip; inner forceps broad at base with long hairs on the middle portion which extend forward beyond the apices.

Legs black; front pulvilli small, shorter than last tarsal joint. Hind tibia with irregular bristles, one larger at middle.

Wings decidedly brown, the veins a little yellow toward the base.

Calypters almost pure white.

Length, 9–11 mm.

Redescribed from the single male type, Vieques Island, P. R., February, 1899 (August Busck); and from seven additional males collected at Chosica, Peru, 3,000 feet, May 8 and 9, 1913, on flowers of *Mikania* (C. H. T. Townsend).

BELVOSIA OCHRIVENTRIS Van der Wulp

Cnephalia ochriventris Van der Wulp, Biologia, Dipt., vol. 2, 1890, p. 47.

Male.—Front at vertex 0.35 of the head width, not widening very rapidly for a short distance. Parafrontals yellow pollinose, near the vertex showing a darker and subshining ground color. Frontal bristles in three irregular rows, with two pairs of proclinate orbitals; face, parafacials, and cheeks silvery with a tinge of yellow; posterior orbits more densely yellow. Antennae reddish about to the arista, remainder black; third joint rather slender except at base, three times the second. Arista distinctly flattened but the apex acute. Vibrissae considerably above the oral margin, the distance equal to the length of the second antennal joint; facial ridges with about eight bristles extending up almost to the arista. Palpi yellow. Parafacials with pale yellow hairs above in an uncommonly large patch; cheek with hairs of same color, and there are some additional ones on the facial ridges outside the bristles; beard pale yellow.

Thorax black with dense, yellowish-gray pollen showing only very narrow, longitudinal lines. Scutellum rather yellow in ground color with dense yellow pollen.

Abdomen red in ground color except in an almost hidden median stripe; first segment subshining at the sides, remainder of the abdo-

men rather uniformly covered with deep yellow pollen, the hind margins of second and third segments not shining, the fourth segment has this pollen to the apex. First and second segments with a single pair of median marginals, third with a marginal row of 8 or 10, fourth with a submarginal row of 8 considerably smaller.

Legs black, front pulvilli elongated, equal to the last two tarsal joints. Hind legs missing in the specimen.

Wings light brown, yellow toward the base. Calypters rather pure yellow.

Female.—Front at vertex 0.37 of the head width, with three pairs of orbitals. Antennae more yellowish, rather slender, the second joint a little more than half the third in length; facial ridges with three widely spaced bristles on one side, two on the other above the vibrissae. Other characters as in the male. The second and third abdominal segments at some angles show a shining reddish hind margin, in other angles this disappears.

Length, 10–11 mm.

Redescribed from two specimens; one male from Higuito, San Mateo, Costa Rica (Pablo Schild); and one female, Potrero, Mexico, April 10, 1923 (H. T. Osborn), reared from "army worms," identified for Hawaiian Sugar Planters' Association. Originally described from the State of Guerrero, in southern Mexico.

Type.—In the British Museum.

BELVOSIA RECTICORNIS Macquart

Gonia recticornis Macquart, Dipteres Exotiques, Suppl. 5, 1854, p. 118 (sep. 98).

Willistonia recticornis Brauer, Sitzungsber. Kais. Mus., vol. 106, 1897, p. 354.

Belvosia bella Giglio-Tos, Boll. R. Univ., Torino, vol. 8, 1893, No. 158, p. 3; Ditt. del. Mess., pt. 3, 1894, p. 30, fig. 6.

Male.—Front 0.30 to 0.32 of the head width at vertex, not widening rapidly for a short distance, beyond which the inner margins of the eyes diverge rapidly to the lower part so that the face is broad. Frontal bristles mostly in two irregular rows, the parafrontals with rather dense yellowish-gray pollen anteriorly, which becomes only a little thinner toward the vertex. Face, parafacials, cheeks, and posterior orbits silvery pollinose with a very slight yellowish cast, the small hairs below the lowest frontals pale and those of the cheek also mostly pale. Antennae brownish black, a little more reddish basally, the third joint about three times the second, considerably broadened in the neighborhood of the arista. The distance from the vibrissae to the oral margin is about equal to the length of the second antennal joint; facial ridges with strong bristles almost up to the arista; palpi reddish brown to brown.

Thorax black, somewhat cinereous on the anterior part, the hind angles a little reddish; scutellum nearly black.

Abdomen black, second segment with a narrow and sometimes rather indistinct basal pale crossband interrupted in the middle; third segment with a gray pollinose crossband, interrupted in the middle, its width depending very much on the angle of view, sometimes covering all but the apical third of the segment, but in most angles about half; fourth segment densely light yellow pollinose to the extreme apex, the upper surface bare, or with a few scattered hairs; first and second segments with a pair of median marginals, third with a row of 8 or 10, fourth with a row of about 6 smaller.

Legs black, front pulvilli elongated, equal to the last two tarsal joints; hind tibia with a row of bristles the whole length, one larger at the middle.

Wings brown, both calypters of the same color.

Female.—Front at vertex 0.33 to 0.35 of the head width; facial ridges less bristly, third antennal joint about two and one-half times the second. Hind tibia with a row of suberect bristles of increasing size on the basal three-fifths, a few smaller beyond.

Length, 9.5–11.5 mm.

Redescribed from 34 specimens of both sexes. Nine were reared by James Zetek at Fort Amador, Canal Zone, from *Hylesia* sp. (Zetek 2445); five from Balboa Heights, Canal Zone (Zetek 2142); one from Ancon, Canal Zone, reared by Zetek from *Hylesia darlingi* Dyar (Zetek 1212); six from Ancon, Canal Zone (A. H. Jennings), one of them reared from *Hylesia* sp.; five specimens from Porto Bella, Panama (A. Busck); two specimens, Paraiso, Canal Zone, bred from *Hylesia* (A. Busck); one from Corozal, Canal Zone (Busck); one specimen from Misantla, Mexico, reared from *Hylesia alinda* (Wm. Gugelmann); four specimens, Guayaquil, Ecuador (J. B. Rorer).

Type.—The type of *bella* is a female labeled "Mexico" in the Zoological Museum of the Royal University at Turin, Italy. I have not seen it.

Until I saw the Vienna Museum material I had called this species *bella* Giglio-Tos. In that collection are two series of 20 specimens in all. The first, of 12 specimens from Brazil, determined on the individual specimens as *Willistonia* by Brauer and Bergenstamm, has a label on 1 specimen, "*Gonia recticornis* Mcq. Vidi Typ. Br." This connects with Brauer's notes on the Macquart types in the Bigot collection, which he received from Verrall for study; in these notes, cited above, Brauer writes that an undetermined species in the Vienna Museum is the same as the Macquart type. He also says that *pfeifferi* Schiner MS. is closely related but somewhat smaller. This connects with the second lot of the Vienna material, eight specimens under Schiner's name. These are labeled "Ind. or.?" and "Pfeifferi det B. B." These do not differ, except slightly in size, from the first series.

BELVOSIA RECTICORNIS variety RUFICORNIS, new

Male.—Front 0.32 and 0.33 of the head width at vertex, widening but little for a short distance, then more rapidly. The face and posterior orbit are silvery white, the facial ridges, parafacials, and cheeks pale yellow pollinose with satiny reflections; parafrontals rather more deeply yellow pollinose, the upper third, however, subshining and somewhat dark; frontals in three very irregular rows, the hairs below them pale yellow, as are also those of the cheek and a few on the facial ridges outside the bristles. Cheek almost half the eye height; antennae red, the third joint tending to become a little brown in the male, more distinctly so in the female. The third antennal joint two and a half times the second, arista thickened almost to the apex, the tip, however, slender. Palpi yellow; beard white.

Thorax black, the sides and scutellum obscurely yellowish, the pollen moderately dense in front.

Abdomen brownish black, second segment with interrupted, basal, light yellow crossband, which in some lights extends almost to the middle of the segment, gradually fading out; third segment with a similar but somewhat more distinct crossband which from some angles covers considerably more than half of the segment; fourth segment covered with dense yellow pollen to the apex; first and second segments with a single pair of median marginals, third with a marginal row, fourth with a submarginal weaker row. The yellowish pollen on the second and third segments is distinctly visible underneath and not so changeable as above.

Legs black; front pulvilli as long as the last two tarsal joints; hind tibia with a row of bristles of increasing size on basal three-fifths, only a few sloping hairs adjacent to these.

Wings light brown, both calypters pale yellow in color.

The pteropleura and adjacent parts bear a considerable cluster of fine, yellow hairs.

Length, 10–11 mm.

Female.—Front 0.37 of the head width, the upper part of the parafrontals subshining, but this region is not sharply limited.

Described from three specimens, Chapada, Brazil (H. H. Smith), from the collection of the American Museum of Natural History, and one female from the Vienna Museum, bearing only the label, "potens p. p. 266. Coll. Winthem."

Paratype.—Male, Cat. No. 40475, U.S.N.M.

BELVOSIA FOSTERI Townsend

Belvosiomima fosteri Townsend, Proc. U. S. Nat. Mus., vol. 49, 1915, p. 413.

Male.—Front 0.45 of the head width at vertex; the eyes diverge from each other along their inner border very slightly so the face in

its lower part is not much wider than the vertex. Frontal bristles in several irregular rows; three proclinate orbitals present; face and parafacials silvery, cheeks and posterior orbits with a yellow tinge, the hairs on the upper parafacial pale, also those of cheeks and some just outside the bristles of the facial ridges. Facial depression decidedly deep, the vibrissae not much above the mouth, facial ridges with very strong bristles almost to the arista. Antennae red at base, third joint becoming brown beyond the arista and nearly black at tip; second antennal joint short, only about one-sixth the length of the third, which is considerably elongated. Arista flattened almost to the apex, which is acutely pointed. Palpi yellow; beard pale yellow.

Thorax black with thin gray pollen; scutellum yellowish brown.

Abdomen black, the sides tinged with reddish in ground color. Second segment with indistinct pale yellowish band, very narrow in most angles, sometimes, however, spreading almost across the segments; third segment with yellow pollen covering almost three-fourths of its length in the most favorable light, but so changeable that it usually seems to cover about one-half; fourth segment entirely deep yellow pollinose with scattering erect hairs. First segment with a small pair of median marginals; second with a normal pair; third with a marginal row; fourth with a sparse marginal row smaller than those on the third. Genitalia small, brown.

Legs black; front pulvilli minute; hind tibia on the outer side with a suberect, irregular row of about 10 bristles.

Wings slightly infuscated, bend of fourth vein with or without slight appendage. Subepaulet orange yellow, calypters pale yellow.

Female.—Front at vertex 0.43 to 0.44 of the head width. Third antennal joint hardly three times as long as the second, more slender at the base than in the male. Abdomen much more reddish than in the male.

Length, 10–11 mm.

Redescribed from original type series, two males and one female, Sapucay, Paraguay (W. T. Foster); and one male sent by the Hawaiian Sugar Planters' Association, collected by F. X. Williams at Campinas, Brazil.

Type.—Female, Cat. No. 19607, U.S.N.M.

BELVOSIA EQUINOCTIALIS Townsend

Triachora equinoctialis Townsend, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 348.
? *Belvoisia insularis* Curran, Amer. Mus. Novitates, No. 260, 1927, p. 4.
? *Belvosia antilliana* Curran, Bull. Brooklyn Ent. Soc., vol. 22, 1927, p. 151, in key but not described; Mr. Curran informs me that by an oversight this name was not changed to *insularis* as intended. It is the same species.

Male.—Front at vertex 0.37–0.39 of the head width, widening from about the level of the posterior ocelli. Frontal bristles in three irregular rows, with two pairs of proclinate orbitals. Parafrontals with yellowish pollen anteriorly, most of their surface subshining and rather dark, a little translucent. Face, parafacials, cheeks and posterior orbits silvery white, the small hairs below the frontals white; cheek with white hair. Antennae reddish-yellow about to arista, remainder more blackish. Third joint hardly three times the second. Arista decidedly flattened almost to the apex, which is more blunt than usual. Vibrissae not far above the edge of the mouth, the distance being about half the length of the second antennal joint. Facial ridges with 6 or 7 bristles extending up almost to the level of the arista. Palpi yellow; beard white.

Thorax black, with rather uniform thin gray pollen. Scutellum reddish.

Abdomen red in ground color at the sides, black in the median portion; second segment with changeable yellowish pollen which is thin and almost invisible over most of the surface, leaving the shining red and black ground color distinctly visible in most angles. Third segment much more densly pollinose with deeper yellow. A median narrow black stripe usually and an apical black or reddish shining band always visible; fourth segment entirely yellow pollinose with scattered black hairs in addition to the usual apical bristles. First and second segments with a single pair of median marginals, third with a row of about 12. Genitalia small, the outer forceps somewhat longer than the inner and decidedly sharp at apex.

Legs black, pulvilli elongated, the front ones almost equal to the last two tarsal joints. Hind tibia with a row of unusually erect bristles on the outer side.

Wings considerable brownish at base, less so apically. Calypters whitish, the anterior with a slight yellow tinge, both with yellow rim.

Female.—Front at vertex 0.35–0.37 of the head width. Three pairs of proclinate bristles, antennae more slender, third joint less than double the second. Facial ridges with only three or four bristles.

Length, 9–10 mm.

Redescribed from the type lot, consisting of five males and two females collected at Piura, Peru, August 28 and September 4 and 8, 1910 (C. H. T. Townsend); the museum also has two additional males from Peru (Townsend), and Professor Hine has sent a female which he collected March 18, 1905, at Panzos, Guatemala. *Insularis* was described from a single female from Barrios, P. R., which I had previously compared with this type series and with some doubt pronounced identical.

Type.—Female, Cat. No. 15191, U.S.N.M.

BELVOSIA WIEDEMANNI, new species

Male.—Front at vertex 0.33 and 0.34 of the head width, widening almost immediately. Face and parafacials, cheeks and posterior orbits light grayish-yellow pollinose. Parafrontals are the same color anteriorly, posterior part a little darker. Frontal bristles very irregularly placed, hardly in three rows. Hairs of upper parafacials black and coarse, few in number. Hairs of cheek pale and fine. Palpi brownish red; antennae nearly black, second joint and extreme base of third a little brown. Arista not flattened, tapering to a fine point. Third antennal joint rather long, three times the second. Vibrissae about the length of the second antennal joint, above the edge of the mouth. Facial ridges bristly almost to arista; the face not much depressed. Pollen of mesonotum gray; scutellum subshining black.

Abdomen almost entirely velvet black above, except the fourth segment which is densely covered with pale yellow pollen to the apex. First abdominal segment without median marginal; second with a single pair; third with a marginal row of 14 or more; fourth with a submarginal row of about 12.

Legs black, front pulvilli rather large but hardly longer than the last tarsal joint.

Wing blackish.

Female.—Front at vertex 0.32 and 0.34 of the head width.

Length, 10 mm.

Described from eight males and five females sent from the Vienna Museum. The specimens have evidently been taken out of alcohol and are somewhat shriveled, hence the width of the front may not hold good with fresh specimens. They all bear the same labels "Hetschko 89 Blumenau," "copulata det. B. B."; "Coll. Winthem."

Two males and two females, paratypes, are retained in the National Museum collection, the remainder including the type returned to the Vienna Museum. The species *Tachina copulata* Weidemann was based upon two specimens belonging to very distinct genera, one of these belonging to the genus *Hystricia* has already been designated as the type, hence a new name is necessary for the present species. I have discussed the original specimens in these Proceedings (vol. 72. 1927, art. 7, p. 10).

Paratype.—Male and female, Cat. No. 40564, U.S.N.M.

BELVOSIA UNIFASCIATA Robineau-Desvoidy

Latreillia unifasciata Robineau-Desvoidy, Myodaires, 1830, p. 105.

Exorista flavicauda Riley, Second Missouri Report, 1870, p. 51; Gen. Index Mo. Repts , p. 88, quoted.

Belvosia unifasciata Coquillett, Revis. Tachin., 1897, pp. 10, 84.—Johnson, Cat. Ins. of New Jersey, 1899; ed. 2, 1909.—Felt, 21st N. Y. Report, 1905, p. 65.—Johnson, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 437.—Brimley, Ent. News, vol. 33, 1922, p. 21.

Goniomyia unifasciata Sherman, Journ. Econ. Ent., vol. 8, 1915, p. 299.—Britton, Check-List Dipt. of Conn., 1920.

Triachora unifasciata Townsend, Muscoid Flies, 1908, p. 105.

Male.—Front at vertex 0.36 to 0.39 of the head width, the eyes not diverging very much to the lower part of the face. Parafrontals with a little pale pollen below, most of the surface dark and subshining. Frontal bristles in three irregular rows, with the addition of two or three proclinate orbitals. Below the lowest frontals are some rather conspicuous dark hairs which in some specimens and at some angles may appear pale in color, at least partly. Face and parafacials white, almost silvery, the former rather broad on the lower part and the latter considerably narrower below than in most species. Cheek about one-fourth the eye height with yellow pollen and mostly blackish hairs. Antennae red at base, third joint black, nearly four times the second. Arista flattened in a uniform width almost to the apex. Vibrissae not very far above the mouth, the distance a little less than second antennal joint; facial ridges bristly almost to the arista. Palpi yellow; beard white.

Thorax black, rather densely gray pollinose, the stripes slender. Scutellum entirely black.

Abdomen black, gray pollinose on the first and second segments, the latter more shining at tip; third segment with pollen slightly more yellowish; fourth segment with deep golden pollen to apex. First and second segments each with a single pair of median marginals; third and fourth with a marginal row.

Legs black, front pulvilli minute; hind tibia with coarse sloping bristles mixed with hairs on the outer side.

Wings light brown. Calypters white, the margin a little darkened.

Female.—Front at vertex 0.36 of the head width, the same in three specimens. Facial ridges more flattened than in the male. Third antennal joint hardly twice the second.

Length, 9.5–11 mm.

About 100 specimens of this species have been examined. Those belonging to the National Museum collection include the following: Two types of *Exorista flavicauda* Riley from Missouri; 1 specimen from Georgia; 2 from New York (Southwick); 38 from the District of Columbia and adjacent Virginia and Maryland, collected by Townsend, McAtee, Shannon, Greene, Quinter, and Aldrich; 14 from Mount Holyoke Gap, Mass. (Townsend); 1, Clarke County, Va. (Aldrich); 2, Chesapeake Beach, Md. (Aldrich). In the Aldrich collection, recently donated to the National Museum, are 18 specimens from Lafayette, Ind., and 4 from Ghent, N. Y., 2 from Castle Rock and Fern Rock, Pa. (Harbeck); 1, Habana, Cuba (C. F. Baker). From Dr. A. L. Melander three specimens were received, one from Dixie Landing, Va. (Townsend); one from Pennsylvania and one

from Illinois (Forbes). From Prof. Jas. S. Hine were received 1 specimen from West York, Miss., and 16 from Ohio, collected by him at Sandusky, Jefferson, Ira, Fort Ancient, Columbus, and Cincinnati. From the American Museum were received one specimen from Forest Hill, N. J. (Weidt); one, Valley of Black Mountains, N. C. (Beutenmüller); one from Mount Vernon, N. Y. (Weidt). The last is a male without orbitals but agreeing otherwise and no doubt belonging to this species.

This species has been reared from the army worm several times, first by Riley (the type of *Exorista flavicauda*). Sherman has published some notes on this habit in the Journal of Economic Entomology (vol. 8, 1914, p. 299). We have no other host record.

The type was from Philadelphia, in the Dejean collection.

BELVOSIA OMISSA, new species

Male.—Front broad, 0.40 of the head width at vertex (the same in four specimens), narrowest at the level of the front ocellus, evenly widening to the lower part of the face. Parafrontals shining dark gray, gradually more pollinose toward the frontal stripe, the frontal bristles in three irregular rows; no orbitals, a few dark hairs below the lowest of the bristles. Parafacials silvery-white, the face more pure white, cheek nearly half the eye height, thickly covered with dark hairs; facial ridges rather flattened, strongly bristled nearly to the arista. Vibrissae not very much above the edge of the mouth, the distance equaling hardly more than half the second antennal joint. Antennae black, the second joint rather reddish-brown, the third fully four times the second. Arista tapering from near the base, apical portion slender. Palpi brown; beard white.

Thorax black, including scutellum; the dorsum gray pollinose, leaving four shining black stripes very perceptible to the naked eye, the inner pair extending only a short distance behind the suture; a short dark median stripe just before the scutellum.

First three segments of abdomen black with rather a uniform gray pollen, which, however, is slightly changeable in some lights; fourth abdominal segment entirely deep orange pollinose on same ground color. First segment without median marginals; second segment with one pair; third segment with a marginal row of about 14; fourth segment with a subapical row of about 10, and rather numerous black hairs scattered over the pollinose surface. Genitalia small, the inner forceps short, black; the outer forceps yellow and considerably swollen, about as long as the inner.

Legs black, front pulvilli shorter than last tarsal segment, the other pulvilli small. Hind tibia with a single dense row of rather short cilia on the outer hind side with one stout bristle just beyond the middle.

Wing subhyaline, brownish along the veins, the third vein with three or four small setules at base. Both calypters white.

Length, 11 mm.

Female.—Front 0.40 of the head width, with three stout proclinate orbitals on each side; palpi brownish-yellow; third antennal joint three times the second.

Length, 11.5 mm.

Described from five males and one female collected near Washington, D. C. The type and one other male are from Falls Church, Va., collected June 10, 1913 (S. A. Rohwer), on flowers of chestnut. Another male was collected near Glen Carlyn, Va. (W. L. McAtee), June 11, 1916; one at Difficult Run, Va., September 14, 1913 (Shannon); and the fifth one at Plummer Island, Md. (H. L. Viereck), July 4, 1916. The single female (allotype) was collected at Falls Church, Va. (C. T. Greene), on Ceanothus flowers, July 4, 1917.

Type.—Male, Cat. No. 40473, U.S.N.M.

BELVOSIA CILIATA, new species

Male.—Front 0.30 to 0.31 of the head width at level of anterior ocellus, widening gradually for a short distance, then more rapidly; frontal bristles in three irregular rows, the hairs below them black and rather coarse; parafrontals with gray pollen below which becomes very thin above, so that the dark ground color shows through to some extent; face, parafacial, cheek and posterior orbit silvery white; cheek with black hairs. Vibrissae a little higher above the epistoma than in most of the species but not quite as high as in *bicincta*. Facial ridges with strong bristles almost up to the arista; third antennal joint black, rather slender, concave on front side, hardly twice as long as the second, which is reddish brown in color. Palpi yellow; beard white.

Thorax black, the sides and scutellum reddish, anterior part with thin gray pollen and with inconspicuous stripes.

Abdomen black, sometimes slightly reddish on the sides, the second segment with at most a mere trace of pollen at base, sometimes none; third segment with a narrow interrupted basal band of pale pollen, or sometimes none at all on upper surface; fourth segment with whitish or pale yellow pollen extending to the tip. First and second segments each with one pair of marginal bristles, third with a marginal row, fourth with a rather scattered submarginal row smaller than those on the third segment.

Legs black, front pulvilli fully as long as the last two tarsal joints. Hind tibia with dense, stout cilia apparently in several rows close together.

Wings and both calypters brown.

Female.—Front rather narrow for this sex, measuring at vertex 0.35 to 0.37 of the head width; three pairs of proclinate orbitals.

Length, 12–14 mm.

Described from 24 specimens of both sexes. The principal series, including type and allotype, were reared by Hy. Edwards from a Hesperid, collected in Mexico, without more definite locality. This series, including 11 specimens, bears the Edwards number 15671 and is received from the American Museum of Natural History. Other specimens received from the same museum include three from Tacubaya, D. F., Mexico (William M. Wheeler), and one from Brazil (H. H. Smith). In the National Museum collection are the following specimens: One from Ancon, Canal Zone, collected by A. H. Jennings, identified by Coquillett as *Belvosia analis* Macquart; one from Mexico without collector, with the same identification; one labeled "on Automeris leucane Mex."; one, Mexico City (O. W. Barrett) from the collection of C. W. Johnson; two, Federal District, Mexico (one from Juan Müller); one, Jalisco, Mexico, bred from *Copaxa lavendera ?*, reared by H. L. Bowers; one, Cordoba, Mexico, collected by William Schaus; one female from Mountain Grove, Mo. (M. P. Somes). In Professor Hine's collection there is one specimen from Mexico. There is another in the Canadian National Collection.

Paratypes.—Males, Cat. No. 40476, U.S.N.M.

BELVOSIA CILIATA var. FORMOSA, new

This variety is the same as the preceding except that the band on the third abdominal segment is very much wider, covering a little over one-half of the segment at the base; it is narrowly but distinctly interrupted.

Described from 11 specimens; 3 males, including the type, are from St. Clair, British West Indies (F. W. Urich), reared from larva of *Automeris* species; the allotype is from Ancon, Canal Zone (A. H. Jennings); 2 specimens in the Canadian National Collection from Mexico, bred from *Saturnia orizaba* by N. K. Bigelow; 1 specimen in the American Museum of Natural History from Chapada, Brazil (H. H. Smith); 1 specimen from Higuito, Costa Rica (Pablo Schild); there is also a male in the Vienna Natural History Museum, which I have lately examined and I am including as a paratype. It is labeled "Brazil Coll. Winthem" and came to me under the identification *esuriens* Fabricius.

Type.—Male, Cat. No. 40477, U.S.N.M.

Some of the specimens approach rather closely to *bicincta*, but can be separated very easily by having the pollen of the fourth abdominal segment extending to the extreme apex.

BELVOSIA VITTATA, new species

Male.—Front 0.36 of the head width at vertex, widening from about the level of the front ocellus. Frontal bristles in about three irregular rows, the parafrontals with changeable dark pollen almost tessellated in effect; the outer and upper portion shining black. Face, cheeks, and posterior orbit white pollinose with satiny reflection; below the frontal bristles there are only one or two black hairs. Cheek with fine brown hairs. Antennae dark red, the third joint very long, seven or eight times the second, black all along the front margin and about the apex. Arista broken off. Vibrissae quite close to the mouth, the distance being as usual about equal to the second antennal joint. Facial ridges not very prominent, with sparse stout bristles extending slightly above the middle.

Thorax black, the pollen distinct so as to leave four black stripes very plainly visible to the naked eye and reaching almost to the scutellum, which is black with gray pollen. Sternopleurals 3; scutellum with scars of five stout lateral bristles, no differentiated apicals and three pairs of small discals.

Abdomen black, with changeable gray pollen on the basal part of the second segment, which is not distinctly limited; the third segment is yellowish gray pollinose on about the basal half, narrowly interrupted in the middle and extending on the venter; the fourth segment is covered with dense rather light-yellow pollen to the apex, but with a narrow median black shining stripe. The first segment has no median marginals, the second a single pair, the third a marginal row, the fourth a sparse submarginal row of six or eight.

Wings brownish, the calypters whitish-yellow, in the center a little infuscated.

Legs black, front ones missing; hind tibia with cilia in a single dense, even row with one stronger bristle at three-fifths the length.

Length, 11 mm.

Described from one male, Sapucay, Paraguay, taken May 24, 1902, by an unknown collector.

Type.—Male, Cat. No. 40469, U.S.N.M.

BELVOSIA FRONTALIS, new species

Male.—Front 0.36 to 0.38 of the head width at vertex, the sides diverging quite rapidly. Face white pollinose, a distinct shade of light yellow in the dense pollen of the parafacial, cheek, and posterior orbit; parafrontals with thin yellowish pollen through which the light ground color shows considerably. In the type there is a sharp line of division just above the lowest frontal, above which the pollen is more distinctly yellow; but in the paratype this line of division is barely perceptible. Antennae deep reddish-yellow, the third joint four times the second. Vibrissae rather close to the oral margin,

facial ridges bristly almost to the arista. The hairs on the upper parafacial are black. Cheek with fine pale hairs which look a little darker in some angles. Palpi pure yellow.

Thorax black, the pollen forming more distinct stripes than in many of the species. Scutellum reddish around the margin, but with gray pollen.

Abdomen black except the last segment, but somewhat damaged in the type, so that it is impossible to describe the third segment very satisfactorily; the fourth segment with pale yellow pollen to the apex covering its whole surface, which is also sprinkled with sparse but coarse black hairs. First segment without median marginal bristles; second with a single pair; third with the usual marginal row; fourth with a rather sparse row of smaller size.

Legs black, the front pulvilli minute; hind tibia with dense, short cilia in a single row, with one bristle at the lowest third. Wings light brown; calypters pale yellow.

Length, 10 mm.

Described from two males collected at Chapada, Brazil (H. H. Smith), received from the American Museum of Natural History.

Paratype.—Male, Cat. No. 40470, U.S.N.M.

BELVOSIA ELUSA, new species

Male.—Front at vertex 0.30 to 0.35 of the head width, not widening for a short distance from the level of the ocelli. Parafrontals with gray pollen below, becoming darker over most of the area. Face, parafacials, cheeks, and posterior orbits white with satiny reflection; the hairs below the frontal bristles and on the cheek are black. Antennae brown, third joint more blackish, a little more than twice the length of the second. Vibrissae about half the length of the second antennal joint above the oral margin; facial ridges with strong bristles extending to the level of the arista. Palpi yellow.

Thorax black, the scutellum and posterior part brownish. The cinereous pollen rather dense before the suture, showing four narrow black stripes.

Abdomen subshining black, the second segment with more or less of a faint basal interrupted band of pale yellow pollen, a similar but much more distinct band on the third segment, which in most angles of view covers about one-half of the segment; fourth segment with pale yellow pollen to the extreme apex, the first and second segments each have one pair of marginal bristles, the third a rather dense row of about 14, the fourth a row of 8 or 10.

Legs black, front pulvilli minute, shorter than last tarsal joint; hind tibia with a row of more or less coarse cilia.

Female.—Front at vertex 0.34 to 0.35 of the head width, the whitish pollen of the anterior part more extended, so that the dark subshining portion is restricted to part of the upper half.

Length, 10–11 mm.

Described from two males and two females, including the type and allotype, collected at Chapada, Brazil (H. H. Smith), received from the American Museum of Natural History; and one male from San Bernardino, Paraguay (K. Fiebrig).

Paratype.—Male and female, Cat. No. 40468, U.S.N.M.

BELVOSIA CANADENSIS Curran

Belvosia canadensis CURRAN, Bull. Brooklyn Ent. Soc., vol. 22, 1927, p. 152.

Male.—Front 0.42 and 0.43, in two, of the head width at vertex, widening rather gradually; parafrontals cinereous pollinose, the pollen becomes thinner in the middle, but still somewhat evident; frontal bristles in about three irregular rows. Face, parafacials, cheeks and posterior orbits white, the parafacial and orbit silvery, the few hairs below the frontals and those of cheek black. Antennae black except at junction of second and third joints, of moderate size, the third joint slightly more than twice the second. Arista flattened for most of its length, but sharply pointed. Vibrissae considerably above the oral margin, the distance about equal to the second antennal joint. Facial ridges with a single row of moderate bristles about to the middle of the third antennal joint. Palpi brown, extreme apex paler; beard white.

Thorax black, with thin gray pollen in front. Hind angles and scutellum dark brown; sternopleurals three, the fourth hairlike.

Abdomen black, third and fourth segments golden pollinose, except a narrow hind margin, which in the third segment only occurs along the middle, the golden pollen extending to the extreme apex of the segment along the sides; in the fourth segment there is a distinct shining black margin all the way around. The first and second segments with a single pair of median marginals; third with a row of 12; fourth with about 8 considerably smaller.

Legs black; front pulvilli minute; hind tibia with a row of bristles of increasing size on the basal three-fifths, six or seven in all, not very large.

Wings blackish, front calypters the same color, hind calypters almost white.

Female.—Front at vertex 0.42 of the head width, the same in three, widening rather rapidly; three proclinate orbitals, the frontals in three irregular rows but not very strong. Third antennal joint less than twice the second.

Length, 9–11 mm.

Redescribed from a male and female paratype, the former from Calgary, Alberta, September 2, 1902; the latter, Douglas County, Kans., May 19, 1923 (W. J. Brown); 1 male collected by Professor

Hine at Fort Ancient, Ohio, June 10–12, 1902; 1 female, Mandan, N. Dak., June 16, 1918 (Aldrich); 1 female, Madison Junction, Yellowstone Park (Melander); and a series of 18 specimens from various counties in Kansas (Beamer, Williams, Brown), received from the University of Kansas collection.

The type is in the Canadian National Collection.

Paratypes.—Male and female, Cat. No. 40371, U.S.N.M.

BELVOSIA LEUCOPYGA Van der Wulp

Belvosia leucopyga VAN DER WULP, Notes from the Leyden Museum, vol. 4, 1882, p. 84; Tijdsch. v. Ent., vol. 26, 1883, p. 27; Biologia, Dipt., vol. 2, 1903, p. 470.

Belvosiopsis brasiliensis TOWNSEND, Revisto Museu Paulista, vol. 15, 1926, pp. 248, 289.

Male.—Front 0.31 of the head width at vertex, the sides nearly parallel for a short distance, then diverging rapidly; face, parafacials, cheeks, and posterior orbits densely white pollinose with satiny reflection. Parafrontals gray pollinose anteriorly, the pollen becoming thinner above so that the dark ground color is quite conspicuous; frontal bristles in two irregular rows, the hairs below them black; hairs of cheek almost all pale. Antennae black, basal joints brownish red, the third joint not quite three times the second. Arista moderately flattened, the apex, however, slender. Vibrissae rather high above the mouth, the distance being greater than the length of the second antennal joint; facial ridges with the bristles almost to the level of the arista. Palpi yellow; beard white.

Thorax black, the posterior angles and scutellum brown pollinose. Sternopleurals four on one side, five on the other.

Abdomen deep black, not very shining, the fourth segment densely yellow pollinose except the apical fourth. The pollen extends all the way down the sides and is interrupted by a slender median line above.

Legs black, front and hind ones broken off.

Wings dark brown, fourth vein with a rather short bend almost angular. Calypters blackish.

Length, 11 mm.

Female.—Front 0.35 of the head width at vertex, somewhat rubbed, the parafrontals a little inflated, with very thin pollen so that the black ground color is conspicuous. From the scars it would appear that most of the bristles are in a single row; there were three proclinate orbitals. The hind tibia has a row of bristles on the basal two-thirds, too much broken to describe further.

Length, 10 mm.

Redescribed from one male and one female, collected at Valera, Venezuela, by Dr. E. P. DeBellard. Van der Wulp described it from Brazil and in 1903 reported it from Yucatan.

BELVOSIA SPLENDENS Curran

Belvosia splendens CURRAN, Bull. Brooklyn Ent. Soc., vol. 22, 1827, p. 153.

Male.—Front 0.40 to 0.42 of the head width at vertex, widening immediately so that the narrowest portion is very short; parafrontals almost entirely shining black, only the lower portion gradually becoming gray pollinose; bristles in about three rows with coarse hairs outside of them. Face gray pollinose, the pollen of the parafacials more shining and thinner so that the dark ground color shows through perceptibly; cheek subshining black with only a little pollen, half the eye height, with black hairs, the lower ones rather coarse; posterior orbits rather plumbeous, shining black above, the hairs below the lowest frontals black. Antennae black, reddish at junction of second and third joints; second joint a little longer than usual, fully half the length of the third; arista thick basally, flattened toward apex, which is, however, acutely pointed. Vibrissae not very high above the oral margin, the distance only about half the length of the second antennal joint; facial ridges with partly double row of medium-sized bristles extending up almost to the arista. Palpi blackish basally; apices brownish-yellow; beard white.

Thorax shining black, but little pollinose in front, the scutellum shining dark brown; sternopleurals five.

Abdomen black, first and second segments subshining, third and fourth golden pollinose except the apical fourth or less, including the marginal row of bristles; first and second segments with a single pair of median marginals.

Legs black; front pulvilli only a little enlarged, about as long as the last tarsal joint. Hind tibia with a row of irregular bristles on the outer side, about 14.

Wings dark brown, both calypters the same.

Female.—Front at vertex 0.40–0.45 of the head width. Parafrontals shining as in male, but not so bristly; the usual three or four proclinate orbitals present.

Length, 13 mm.

Redescribed from one male and one female paratype, Aweme, Manitoba, bred from Lepidopterous larva by E. and A. Criddle. I have also seen a male and female from Glen Ellyn, Ill., in Professor Melander's collection, and a specimen from Kansas in that of the University of Kansas.

Type.—In Canadian National Collection.

Paratypes.—Male and female, Cat. No. 40372, U.S.N.M.

BELVOSIA BOREALIS, new species

Male.—Front 0.36 to 0.38 of the head width at vertex, widening rather gradually for some distance; frontal bristles in three irregular rows. Parafrontals white pollinose below, the pollen becoming

considerably thinner above so as to show the dark ground color to some extent. Face, parafacials, cheeks and posterior orbits densely silvery white pollinose. The hairs below the upper parafacials and those of the cheeks black. Antennae black, rather long, the third joint about two and a half times the second; vibrissae situated considerably above the oral margin. Facial ridges bristly almost to the arista. Palpi yellow to brown, beard white.

Thorax black, dorsum quite shining with very thin pollen anteriorly; scutellum dark brown; sternopleurals usually six or seven. Scutellum with six or seven pairs of lateral bristles, no distinct apicals.

Abdomen black and subshining on the first two segments, the remaining two deep golden pollinose except apical fourth. First segment with four to six spiny marginals, second segment with the same number; third and fourth with a marginal row. Venter with clusters spines mostly on the tergites.

Legs black, front pulvilli elongated, almost equal to last two tarsal joints. Hind tibia with rather long bristles and numerous coarse hairs.

Wings blackish, both calypters of the same color.

Female.—Front 0.39 to 0.40 of the head width at vertex.

Length, 15–16.5 mm.

The species is very robust, one of the females measuring 9 mm. across the abdomen.

Described from 5 males and 15 females. The type is from Harrisburg, Pa. (Sanders), and two females, including allotype, are from the same place (Walton); one female, Rockville, Pa. (Champlain); one female, Inglewood, Pa. (Kirk); one, Linglestown, Pa. (Fisher, this with the two preceding in Mr. Walton's donation to the Museum); one male, Charter Oak, Pa. (Knull); three females, Springfield, Mass. (Dimmock), identified about 1894 by Brauer and Bergenstamm as "*Latreillia bifasciata* Fab.;" One, Colebrook, Conn. (Wheeler), received from C. W. Johnson; one, Reading, Pa.; one, Pimmit Run, Va. (Knab); one, Difficult Run, Va. (Shannon); two, Ira, Summit County, Ohio (Hine); one, Agricultural College, Miss. (Turman, received from C. H. Curran). From the American Museum were received two females from Black Mountains, N. C. (Beutenmüller), and one from West Farms, New York City (Angus).

Type.—Male, Cat. No. 40481, U.S.N.M.

BELVOSIA BIFASCIATA Fabricius

Musca bifasciata Fabricius, Systema Ent., 1775, p. 777; Ent. Syst., vol. 4, 1794, p. 325; Syst. Antl., 1805, p. 299.

Ocyptera bifasciata Latreille, Dict. d'Hist. Nat., vol. 24, 1804, p. 195.

Tachina bifasciata Wiedemann, Auss. Zweifl., vol. 2, 1830, p. 305.

Latreillia bifasciata Robineau-Desvoidy, Myodaires, 1830, p. 104.

Nemoraea bifasciata Macquart, Hist. Nat. Dipt., vol. 2, 1835, p. 104.—Bigot, in Sagra's Cuba, vol. 7, 1857, p. 342.

Belvosia bifasciata MACQUART, Dipt. Exot., vol. 2, pt. 3, p. 214 (sep. p. 57).—OSTEN SACKEN, Cat. N. Amer. Dipt., 1878, p. 153.—VAN DER WULP Tijdsch. v. Ent., vol. 26, 1883, p. 23; Biologia, Dipt., vol. 2, 1888, p. 30, pl. 2, fig. 8, and 1903, p. 469.—RILEY, Fifth Mo. Rept., 1873, p. 140, fig.; Fourth Rept. U. S. Ent. Comm., 1885, p. 110.—RÖDER, Stett. Ent. Zeit., 1885, p. 345.—TOWNSEND, Psyche, vol. 8, 1897, p. 128.—COQUILLETT, Revis. Tachin., 1897, pp. 10 and 84.—JOHNSON, List Ins. N. J., 1899.—HOWARD, Insect Book, 1902, pl. 22, fig. 15.—JOHNSON, Proc. Acad. Nat. Sci. Phila., 1895, p. 332; Bull. Amer. Mus. Nat. Hist., vol. 32, 1913, p. 72.—F. H. SNOW, Kans. Univ. Sci. Bull., vol. 2, 1903, p. 217.—WILLISTON, Trans. Amer. Ent. Soc., vol. 13, 1886, p. 302; Insect Life, vol. 5, 1893, p. 238.—HARVEY, Bull. Brit. Col. Ent. Soc., December, 1906, p. 2.—WALTON, Proc. Ent. Soc. Wash., vol. 14, 1912, p. 22.—REINHARD, Ent. News, vol. 30, 1919, p. 280.—BRITTON, Checklist Dipt. Conn., 1920.—GREENE, Proc. U. S. Nat. Mus., vol. 60, art. 10, p. 14, fig.—BRIMLEY, Ent. News, vol. 33, 1922, p. 20.—WALCOTT, Checklist Ins. Porto Rico, 1923, p. 222.—JOHNSON, List Dipt. New England, 1925, p. 193.

Lalage bifasciata ROBINEAU-DESVOIDY, Dipt. Env. Paris, vol. 1, 1863, p. 563.

Willistonia bifasciata BRAUER and BERGENSTAMM, Zweifl. Kais. Mus., pt. 4, 1889, p. 97, fig.; pt. 6, 1893, p. 123.

Latreillimyia bifasciata TOWNSEND, Muscoid Flies, 1908, p. 103.—JOHNSON, Cat. Ins. New Jersey, 1910, p. 779.

Male.—Front from 0.40 to 0.45 of the head width at vertex, widening immediately, as the upper portion of the eye is very narrow, almost running to a point. Parafrontals almost silvery below, the pollen becoming thinner upward so as to show the black ground color over a considerable area. Frontal bristles in about three very irregular rows. Face, parafacials, cheeks, and posterior orbits silvery pollinose, the parafacials especially shining. Hairs below the lowest frontals black, cheek with black hair. Antennae black, reaching nearly to the vibrissae, the third joint about three times the second. Vibrissae considerably above the mouth, the distance nearly equal to the length of the second antennal joint. Facial ridges bristly to a little below the arista. Palpi varying from yellow to blackish; beard white.

Thorax black, somewhat shining, with thin pollen anteriorly. Sternopleurals from four to six.

Abdomen black on first two segments, but the second sometimes showing a trace of pollen at the base; third and fourth segments with broad dense bands of golden pollen covering all but the apical fourth or fifth, which is shining black. The first and second segments each have a single pair of median marginals, the third and fourth a marginal row. Venter without unusual development of soft hair.

Legs black, front pulvilli noticeably smaller than in most of the species, hardly as long as the last tarsal joint. Hind tibia with several large bristles on the basal three-fifths of the outer side.

Wings blackened; front calypters brown, the hind one of the same color, at least on the basal half, tending to become paler on the apical half, especially in southern and western specimens.

Female.—Front at vertex from 0.37 to 0.47 of the head width, widening immediately as in the male. The pollen of the parafrontals is in some cases thin enough to show a considerable dark area, but in most of the specimens is not very dark. Third antennal joint only a little more than twice the second.

Length, 11–14.5 mm.

Redescribed from 99 specimens of both sexes as follows: 11 from the vicinity of the District of Columbia, including Chesapeake Bay, Md., and Oak Grove, Va. (Viereck, Shannon, Greene, Aldrich, Townsend, and McAtee), also 3 reared by the late Henry F. Schoenborn from *Citheronia regalis* Huebner and *Anisota rubicunda* Fabricius, and 1 reared by Pergande from the former host; 4 from Sandusky, Columbus, and Cincinnati, Ohio (Hine, Allen); 2, North Carolina, 1 being from Southern Pines (Manee); 5 from Florida, 2 collected by Charles Palm without other data, the other 3 from Miami (Townsend); 4 from Mississippi, 1 with illegible place (J. I. Hurst), 2, Agricultural College (Allen), and 1, McHenry (Allen); 2 from Arkansas, 1 being from Lake Village (E. E. Holley), the other, Benton (D. G. Hall); 15 from Texas, 13 of these being from College Station (Reinhard), 1 Bryan and 1 Austin (Melander); 37 from Arizona, of which 36 are from Sabino Basin and Sombrero Butte (Townsend), 1 from Fort Grant (Hubbard); 1 from Socorro, N. Mex. (Williston); 1 from Lancaster, southern California, reared by Koebele from *Hemileuca* sp.? and 1 from San Pedro Madero, Chihuahua, Mexico (Townsend); 4 additional specimens are without localities.

There are nine specimens, correctly determined, in the Vienna Museum material. Two are from Kentucky; three are labeled "Texas Boll"; two "Am. b. Georgia"; one "N. America"; and one only labeled "Pöp. 852," which I take to mean the collector Pöppius.

The following seven specimens were sent by C. W. Johnson: One each from Hamilton, Mass. (J. B. Smith, reared from *Telea polyphemus* Linnaeus); Dedham, Mass. (Johnson); Philadelphia, Pa. (Johnson); Suffolk, Va. (Johnson); St. Augustine, Fla. (Johnson); Bear Creek Canyon, Colo.; and Blanco, Tex.

From the American Museum the following six specimens were received: Two from Jacksonville and Biscayne Bay, Fla. (Slosson); one each from Brooklyn, N. Y. (Akhurst); Brownsville, N. Y. (Woodruff); Browns Mills, N. J.; and one from the Williston collection without locality.

From the University of Kansas were received 10 specimens, 5 of them from Bourbon, Morris, Marshall, Wilson, and Morton Counties (Beamer, Martin, Williams); 1, Magdalena Mountains, N. Mex. (Snow); 1, Cochise County, Ariz. (Snow); 1, Galveston, Tex. (Snow); and 1, District of Columbia.

Originally described from the West Indies and redescribed by Wiedemann from the original specimens and some additional ones which he refers to as South American. I have been unable to discover any trace of the original Fabrician material, or even of the specimens added to the species by Wiedemann. On this account the identification is to some extent a traditional one, the species being the common one of eastern North America which is identified in most collections under this name. It is reasonably certain that Robineau-Desvoidy had this species identified as *bifasciata* since he refers to the black calypters and mentions specimens from Virginia and Carolina, but he probably had more than one species, as he mentions other specimens from the Antilles. In Robineau-Desvoidy, 1863, a Fabrician specimen is redescribed, the statement being made that it bears a label in the handwriting of Fabricius. This seems to agree with the accepted interpretation.

The literature of this abundant species is confused, since up to the present several species have not been separated. Osten Sacken and Coquillett followed Macquart in including *bicincta* as a synonym; Williston first indicated the distinctness of the latter, but in 1893 hesitated to recognize the forms he figured as distinct species. He suggested, however, that if these characters are specific, there must be "at least a dozen species" in America. Walton in tabulating variations of chaetotaxy in *bifasciata* in 1912 included in his series of ten specimens three which I now place in *townsendi* and four of my *borealis*. In the distribution it is distinctly a species of the Temperate Zone, although not rare in southern Florida and represented by one specimen from Guatemala.

The species has been reared from Lepidoptera, mostly the large kinds; published host records include *Citheronia regalis* Fabricius (Coquillett, 1897), *Basilona imperialis* Drury (Brimley, 1922), *Anisota senatoria* Smith and Abbott (Brimley, 1922), *Ceratomia undulosa* Walker (Brimley, 1922), *Dryocampa rubicunda* Fabricius (Riley, 1873), *Hemileuca* sp. (Coquillett, 1897). An unpublished host is *Ceratomia amyntor* Huebner, the parasite being reared by C. Zeimet at Black Mountain, N. C.

BELVOSIA ARGENTIFRONS, new species

Male.—Front at vertex 0.34 to 0.37 of the head width, not widening for a short distance. Face, posterior orbit, and cheek silvery, this color extending in an unusual manner upon the parafrontals almost to the vertex; frontal bristles mostly in one row, but a few irregular, the hairs below them black; cheek two-fifths of the eye height with black hairs, some quite coarse. Vibrissae not so far above the mouth as in many of the species, the distance being hardly equal to the

length of the second antennal joint; antennae brownish black, the third joint three times the second; palpi yellow.

Thorax black, the gray moderately dense with faint stripes. Scutellum with pollen of the same color as the thorax but more dense.

Abdomen black, second segment with a very narrow interrupted basal pollinose band of pale yellow; third and fourth segments with dense yellow pollen, the apical fifth however shining black. Genitalia small, shining black, the outer forceps concolorous, with rounded tips.

Legs black; front pulvilli slightly shorter than the last two tarsal joints; hind tibia on outer side without cilia, but with a scattered row of bristles of increasing size on the upper three-fifths.

Wings light brown, both calypters white, with only a slight tinge of yellow.

Female.—Front at vertex 0.37 to 0.40 of the head width, the parafrontal silvery below, but with a larger dark region above than in the male.

Described from six specimens of both sexes. Three males and two females, including type and allotype, were reared by C. T. Greene at Falls Church, Va., from a lepidopterous pupa (Hopkins 14802 F); one specimen from Georgia which was figured in Howard's Insect Book (1902, plate 22, fig. 15) as *Belvosia bifasciata;* the remaining specimen, a male, was sent for study by the American Museum of Natural History; it was bred at Brooklyn, N. Y., by J. Akhurst, host not given.

Type.—Male, Cat. No. 40478, U.S.N.M.

BELVOSIA TOWNSENDI, new species

Male.—Front at vertex 0.32–0.36 of the head width, continuing forward quite perceptibly before becoming wider; parafrontals very distinctly yellow pollinose, the ground color showing through very little except quite far back. The bristles are in three irregular rows, the smaller hairs below them and on the cheeks are very distinctly black. Face, parafacials, and cheeks as well as posterior orbits silvery pollinose. Antennae black, junction of second and third segments reddish, the third fully twice as long as the second, with almost parallel sides. Vibrissae about as far above the epistoma as the length of the second antennal joint. Facial ridges with smallish erect bristles not quite to the level of the arista. Just outside the bristles there are also some distinct black hairs. Palpi yellow; beard white. Thorax black, gray pollinose in front, the scutellum, except the base, with yellowish pollen.

Abdomen black, the second segment with a distinct but very narrow and widely interrupted basal whitish pollinose crossband. Third

and fourth segments with golden pollen except on the apical fourth; the black hind margin becomes a little narrower underneath; first and second abdominal segments each with a single pair of median marginal bristles; third and fourth with a marginal row. Genitalia rather small, the outer forceps rather narrow at base and broad at tip.

Legs black, front pulvilli elongated, equal to the last two tarsal joints. The hind tibia on outer side with about eight irregular sloping bristles and next to them on the hind edge some sloping hairs.

Wings brown; calypters very pale brown, appearing nearly white at first glance.

Length, 11 mm.

Female.—Front 0.36–0.37 of the head width, the parafrontals without yellow pollen, but rather dark and semishining. Antennae tending toward reddish.

Length, 12 mm.

Described from 54 specimens of both sexes; the principal series, consisting of 24 males and 4 females (including type and allotype), was collected by C. H. T. Townsend between July 29 and August 1 at Oak Grove, Va., on flowers of carrot; 2 specimens, male and female, were reared from *Citheronia regalis* by Riley on July 17 and September 17, 1873, the first being mentioned by Coquillett under *bifasciata* on page 10 of his Revision of the Tachinidae; in the Aldrich collection are 4 specimens, 3 from Pennsylvania originally collected by C. W. Johnson, 1 of which is labeled "from chrysalis of *Eacles imperialis* 6/9/1891"; the fourth specimen collected at Lafayette, Ind. Recently received from C. W. Johnson for identification are two specimens, one male from Clementon, N. J., August 29, 1919, the other a female from Bainbridge, Ga. (J. C. Bradley). From Walton's collection are two males and one female, one male from Hertford, N. C., the other two from Catawissa, Pa., reared from *Eacles imperialis* from the same larva. These are Nos. 1, 2, and 4 of the analytical table published by Walton,[2] where they are included under *bifasciata;* two females from H. W. Allen, one collected at Mount Laurel, N. J., by L. B. Parker, the other collected at Palmyra, N. J., September 10, 1924, by R. J. and N. B. Sim; two females from Clemson College, S. C., September 23, 1908 (F. Conradi), received from J. O. Pepper; three males from the American Museum of Natural History, one collected by Mrs. A. T. Slosson at Lake Toxaway, N. C., one collected in New York, reared from *Eacles imperialis* by Hy. Edwards, the third from Newark, N. J., July, 1923; one from Wauseon, Ohio, sent by Prof. J. S. Hine; one male, Falls Church, Va., reared by C. T. Greene from large lepidopterous pupa (Hop. 14802 F); three males, Black Mountain, N. C., reared from *Ceratomia amyntor* on May 23, 1923, by Carlo Zeimet; one male, near Peaks of Otter above 3,000 feet, collected by

[2] Proc. Ent. Soc. Wash., vol. 15, 1913, p. 27.

William Palmer; one male, Falls Church, Va. (Greene); and one male from Riley County, Kans., in the University of Kansas collection.

Type.—Male, Cat. No. 40466, U.S.N.M.

Named in honor of Dr. C. H. T. Townsend, a very keen and experienced collector of the muscoid flies.

BELVOSIA BICINCTA Robineau-Desvoidy

Belvosia bicincta Robineau-Desvoidy, Myodaires, 1830, p. 103.—Williston, Trans. Amer. Ent. Soc., vol. 13, 1886, p. 302.—Townsend, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 89; Ann. and Mag. Nat. Hist., vol. 19, 1897, p. 33.—F. H. Snow, Kans. Univ. Sci. Bull., vol. 2, 1903, p. 217.—Johnson, Proc. Acad. Nat. Sci. Phil., vol. 46, 1894, p. 278; Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 436.

Senometopia bicincta Macquart, Hist. Nat. Dipt., vol. 2, 1835, p. 112.

Belvosia bifasciata Fabricius (part), Macquart, Dipt. Exot., pt. 2, No. 3, (Mem. Soc. Sci. et Arts Lille, 1843), p. 212 (sep. 55).—Osten Sacken, Cat. N. A. Dipt., 1878, p. 153.—Van der Wulp, Tijdsch. v. Ent., vol. 26, 1883, p. 23.—Coquillet, Revis. Tachinidae, 1897, p. 84.

Belvosia piurana Townsend, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 349.

Male.—Front 0.27 to 0.32 of the head width at vertex, widening rapidly after a short distance; frontals in two irregular rows, one containing the largest bristles is rather distinct; parafrontals densely covered with dark hair which inclines toward the median line above, while on the lower part it becomes somewhat more proclinate especially near the orbits. The parafrontals are almost silvery pollinose at the lower end, but the pollen rapidly becomes thinner upward and in their middle and upper portion they are dark and subshining. Face, parafacials, cheeks and posterior orbits silvery white pollinose. The face is a little less glistening. The hairs immediately below the frontal bristles and those of the cheek are black. Antennae brownish black, smaller than in related species, reaching a little more than half of the distance to the oral margin; second joint somewhat elongated, from one-half to two-thirds the length of the third. The vibrissae are a little higher above the oral margin than in any of the related species, although some have nearly the same distance. Facial ridges bristly up to about the middle of the third antennal joint, somewhat less than half of the total height. Palpi unusually yellow; beard white.

Thorax black, becoming brown behind, anterior portion with thin gray pollen. Scutellum shining brown.

Abdomen black, frequently with a trace of red in the ground color of the sides; second segment with a narrow basal pollinose band of gray or pale yellow interrupted in the middle; third segment with a much broader band of the same color, which is very slightly or not at all interrupted; fourth segment with denser and usually deeper yellow pollen on the basal two-thirds or three-fourths, the apex, how-

ever, very distinctly subshining black. First segment with a small pair of median marginals; second with a normal pair; third with a marginal row; the fourth has the usual row of bristles mixed with long hairs.

Genitalia brownish-black, both pairs of forceps moderately elongated, the inner bent up at tip, the outer ones slender with parallel sides, the tip bluntly rounded.

Legs black, front pulvilli longer than the last two tarsal joints; hind tibia ciliated on the outer side with dense sloping bristles of uniform size, mostly in a single row.

Wings brown, calypters varying from nearly white to brown.

Female.—Front 0.33 to 0.35 of the head width at vertex, the parafacials with denser white pollen than in the male, so that the dark ground color shows through much less distinctly, the frontal bristles are mostly in a single row with the addition of three proclinate orbitals; the hairs of the parafrontals are much shorter than in the male and are inclined in several directions. Spines of hind coxae long and stout as in *spinicoxa*. Ciliation of hind tibia coarser and less regular than in male.

Length, 11.5–14 mm.

Redescribed from 82 specimens of both sexes; 35 of these were collected in southern Brazil by H. H. Smith and received from the American Museum of Natural History; from the same museum there is one from Coparo, Trinidad. Eleven specimens were received from Prof. Jas. S. Hine, including five from Bartica, British Guiana, April 13–May 4, 1901; one from Puerto Barrios, Guatemala, March, 1905, and four from Holguin, Cuba, December 31, 1904, and March 7, 1905. These Cuban specimens agree in having black palpi and blackish calypters. Two specimens are from the Canadian National Collection—one, British Guiana; one, Tropical Research Station of the New York Zoological Society, Kartabo, British Guiana. From the Hawaiian Sugar Planters' Experiment Station were received two specimens from Blairmont, British Guiana, and one from Mera, Ecuador, all collected by F. X. Williams. In addition to the material cited, the National Museum has 18 specimens with the following data: Three from San Antonio, Tex. (Crawford); one, Brewster County, Tex. (Mitchell and Cushman); one from Rio Piedras, P. R.; one from Higuito, San Mateo, Costa Rica (Schild); one, Puerto Barrios, Guatemala (Deam); one, Culebra, Canal Zone; two, Jamaica, "reared from hawk moth pupa"; and three specimens collected in Bolivia by Dr. W. M. Mann while a member of the Mulford Biological Exploration. One of the last lot is from Rurrenabaque, Beni; one from Cavinas, Beni; the third from Rio Ivon; one from Sapucay, Paraguay. Also 10 specimens from Sullana and Piura, Peru (Townsend), types of *Belvosia piurana* Townsend. Three specimens from

C. W. Johnson, Caura Valley and Ciudad Bolivar, Venezuela, and Bartica, British Guiana.

In the Vienna Museum material are 11 specimens; 7 in one series are labeled "Saida Exp. 1887. Dr. Paulay. R. d. Janeiro, aus ein. gr. Raupe gez."[3] Of the four other specimens, one is "Brasilien," and "Willistonia bei esuriens. Fühler anders"; another is also from Brazil and is labeled "esuriens coll. Winthem"; and in faded brown ink, "T. esuriens H. Musca es. F. Para. Brasilia." The tenth is labeled "Ind. or." "Willistonia det. B. B."; and on a folded paper I find "Ind. or. oder Amazonen fl." The last bears "Wthm" and "Willistonia det. B. B." Although two of these bear the name *esuriens*, they do not agree with Wiedemann's statement that the third antennal joint in that species is more than twice as long as the two preceding.

The types of *bicincta* were said to be from Carolina and the Antilles.

BELVOSIA POTENS Wiedemann

Tachina potens WIEDEMANN, Auss. Zweifl., vol. 2, 1830, p. 299.
Willistonia potens BRAUER and BERGENSTAMM, Zweifl. Kais. Mus., pt. 5, 1891, p. 403.
Belvosia potens ALDRICH, Proc. U. S. Nat. Mus., vol. 72, art. 7, p. 33.

Male.—Front at vertex 0.34 of the head width, the narrowest point being directly across the anterior ocellus; the entire front of the head and the posterior orbits are silvery pollinose, the frontal stripe, however, brown. In this specimen the reddish ground color of the parafacials, facial ridges, and cheeks shows through to a noticeable extent and the suture is distinctly bordered with a darker tinge to its lowest end. Frontal bristles in a single row, the hairs below the lowest are black as are also the hairs of the cheek. Face considerably depressed in the middle, the vibrissae about the length of the second antennal joint above the oral margin; facial ridges with well-developed bristles up to a point above the middle of the third antennal joint. Antennae black, second joint more dark brown with a tinge of red at the junction with the third, which is three times as long as the second and a little tapering. Palpi dark yellow, cheek almost half the eye height, beard white.

Thorax brownish black with usual thin pollen, more distinct in front. Scutellum brown with four pairs of bristles, the median pair of the same appearance as the others. The disk has about a dozen depressed small bristles. Calypters brown. Sternopleurals 4 on one side, 5 on the other.

Abdomen black, with faint reddish tinge at the sides; third segment with only a very narrow basal interrupted, white, pollinose crossband,

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[3] A note on this material occurs in Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 7, 1894, p. 580.

hardly more than a line; fourth segment with dense pale yellow pollen, the apical third black.

Legs black, front pulvilli slightly longer than last two tarsal joints; hind tibia on outer side with a row of small, suberect bristles mixed with a few hairs not so bushy in appearance as in many species.

Wing brown throughout, narrow at apex, bend of fourth vein rectangular and rounded, its distance from the hind margin less than half of that to the large crossvein; third vein with two bristles.

Genitalia smaller than in most of the species, the inner forceps black, closely pressed together near tip and bent forward almost with an angle; outer forceps hardly so long, dark yellow in color, flat and bluntly rounded at tip.

Female.—The front is not silvery in the female, but covered with rather dense gray pollen through which the dark ground color is slightly visible.

Length, 10 mm.

Redescribed from Wiedemann's type specimen which was received for examination from the Vienna Natural History Museum. One additional male has been examined from Brazil, sent by C. H. Curran; and there are two females in the National Museum collection from Ypiranga, Sao Paulo, Brazil (Fonseca).

BELVOSIA NIGRIFRONS, new species

Female.—Front rather broad, measuring at vertex 0.38 of the head width (the same in two specimens, the other not in condition to measure), widening rapidly so that the inner border of the eye when viewed from in front is perceptibly concave. Parafrontals shining blackish gray along the inner border next to the frontal stripe, with gray pollen; frontal bristles in a single row, with some rather stout reclinate bristly hairs just outside of them; three or four proclinate orbitals of varying size. Parafacials pure white, slightly glistening; cheeks and posterior orbits of the same color. The parafacials are a little wider than usual. Vibrissae about the usual distance above the mouth; facial ridges not very prominent, bristly almost to the level of the arista. Antennae black, reddish between the joints, the third joint about twice the second, reaching nearly to the vibrissae. Cheek with black hairs; there are also a few minute black hairs on the parafacial, just below the lowest frontals.

Thorax black, rather densely gray pollinose along the front border, the scutellum with reddish ground color and brown pollen.

Abdomen black, first two segments shining; third segment shining on about the apical half, the basal half bearing an interrupted gray fascia, which fades out posteriorly; fourth segment with dense very pale yellow pollen, except the narrow apex bearing the bristles, which is shining black; the pollinose portion is destitute of hairs.

Legs black, hind tibia with several large suberect bristles on the outer hind side of increasing size, the largest a little below the middle. The pulvilli are decidedly small.

Wings and calypters uniformly blackened; four or five bristles on base of third vein.

Length, 10.5 mm.

Described from three females.[4] The type and one other female were reared from pupae of *Callosamia colleta*, which were collected at Mirasol in the Republic of Salvador at 4,000 feet altitude, by F. Deininger. The adult emerged November 20, 1913. The third specimen was reared at La Laguna, Republic of Salvador, August 1913, by the same collector, from pupa of *Attacas orizaba*; received from C. W. Johnson.

Type.—Female, Cat. No. 40472, U.S.N.M.

BELVOSIA LATA, new species

Female.—Front at vertex 0.35 to 0.37 of the head width, increasing in width rapidly; frontal bristles mostly in a single row, with three proclinate orbitals; parafrontals with rather plumbeous pollen, nearly black in some angles; face, cheeks, and posterior orbits densely white pollinose, almost silvery. The hairs below the frontals are black; cheek one-half the eye height, with black rather sparse hairs. Antennae black, more or less reddish at the junction of the second and third joints, the third somewhat less than twice the second. Vibrissae considerably above the level of the mouth, not quite so much as in *bicincta*. Facial ridges rather flat, bristly about half way. Palpi yellow; beard white.

Thorax black, anterior part densely cinereous pollinose, the hind edge and scutellum with brown pollen. Sternopleurals 3–4.

Abdomen deep black, hardly at all shining, second segment without any basal pale pollen; third segment with a very narrow interrupted basal band of pale yellow; fourth segment with dense light yellow pollen covering all but the apical fourth, which is strikingly black. First abdominal segment with one pair of stout blunt median marginals; second with two or three pairs, which like the marginal row on the third segment are uncommonly stout, erect, and blunt; the second segment also with one bristle of this kind on the margin at the side; the fourth segment with a submarginal row of about 12, almost as stout as on the third segment. Between these and the extreme tip there is another row of smaller bristles. Venter with stout spines mostly on the inflexed tergites.

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[4] A male and 7 females of *Belvosia nigrifrons*, new species, were received later from P. V. Siggers, La Cieba, Honduras. He reared them from a single larva of a large moth of the genus *Rothschildia*. The male has a narrower basal pale band on the third segment, and the front is not so strikingly darkened, being silvery with a perceptible dark tinge. The front in the male is narrowest at the vertex, where it is 0.33 of the head width.

Legs black, coxae with strong curved bristles or spines. Hind tibia with a row of erect bristles of increasing size ending just before the middle; rather numerous small hairs and bristles extending all the way to the tip.

Wings brown, both calypters deeply infuscated.

Length, 14–15 mm.

Described from four females; two, including the type, were collected at Puerto Barrios, Guatemala, March 5, 1905, by Prof. Jas. S. Hine, from whom they were received; another was collected in Brazil by H. H. Smith and was received from the American Museum of Natural History; the fourth is in the collection of the Vienna Museum, labeled "Schott. Brasilien," and "Willistonia det. B. B." This last has but three marginals on the second abdominal segment, but agrees in other characters, especially in the dense spines of the middle ventral region.

Type.—Female, Cat. No. 40471, U.S.N.M.

BELVOSIA SMITHI, new species

Male.—Front rather narrow, 0.30 to 0.32 of the head width, the narrow space continuing a little in advance of the ocelli, thence rapidly widening. Frontal bristles in three irregular rows, the outer not very strong. Parafrontals with thin somewhat plumbeous pollen. Face, parafacial and cheek with shining white pollen, the last with yellowish brown hairs which in certain lights look pale; a few dark hairs below the frontals on the parafacial, but these are not quite black in some lights. Facial ridges bristly more than halfway. Third antennal joint black, noticeably tapering toward the tip, twice as long as the second; the first and second joints yellowish brown. Vibrissae almost half the length of third joint above the oral margin; palpi yellow; beard white.

Thorax black, brownish along the sides, with gray pollen, that of the scutellum more brown.

Abdomen subshining black, the third segment with a narrow and sometimes faint interrupted pale pollinose band at extreme base; fourth segment pale yellow pollinose, except the apex including the bristles and a distinct median black line; the pale pollinose portion has a few erect hairs rather large on the sides and the black of the apex expands underneath to include the whole width of the segment; in other words, the pale pollen does not extend much below the middle of the side of the segment; first and second segments with a single pair of median marginal bristles. The venter has rather striking soft black hair which is dense on the second and third segments, but does not form distinct patches. Genitalia blackish, outer forceps somewhat paler, not distinctly swollen.

Legs black, front claws and pulvilli much elongated, the latter as long as the last two tarsal joints. Hind tibia with dense ciliation in several rows.

Wings uniformly brown, rather long and narrow. Bend of fourth vein rather close to hind margin, the distance being about half of that between the hind crossvein and the bend. Both calypters brown.

Length, 14–15 mm.

Female.—Front at vertex 0.36 of the head width; pollen of head as in male. Antennae slightly shorter, the third joint little enlarged at base, of more uniform width. Hairs of cheek and upper parafacial decidedly black. Ciliation of hind tibia rather coarser and more bristly than in the male.

Length, 12 mm.

Described from two males and one female, collected at Chapada, Brazil, by H. H. Smith. Sent for identification by the American Museum of Natural History. The male paratype is retained by the National Museum.

Named in honor of the late H. H. Smith, a wonderfully capable and energetic collector of insects.

Paratype.—Male, Cat. No. 40479, U.S.N.M.

BELVOSIA SPINICOXA, new species

Male.—Front rather narrow at vertex, measuring 0.34 to 0.37 of the head width; the sides above subparallel for a short distance; parafrontals shining brownish-black, more pollinose adjacent to the frontal stripe. Frontal bristles in two or more irregular rows, a few black hairs below the lowest ones; parafacials pure glistening white; face and cheeks of the same color. Vibrissae a little higher above the mouth than in most of the species, almost as in *bicincta*. Antennae black, second joint brown, the third a little over twice the second, considerably swollen at the base near the arista, which tapers evenly to its apex. Facial ridges moderately prominent, bearing small bristles a little more than half way to the base of the antennae. Palpi yellow.

Thorax black with the usual pale pollen anteriorly. The scutellum brown in ground color and with brownish pollen.

Abdomen black in ground color; base of second segment with a very narrow pale fascia, broadly interrupted in the middle; second segment densely yellowish white pollinose on the basal half or more, gradually fading out posteriorly; fourth segment densely pollinose with light yellow except rather broad apical black portion including the marginal bristles, the light yellow part destitute of hairs. The first and second segments have one pair of marginal bristles, the third and fourth a marginal row.

Legs black, front pulvilli nearly as long as last two tarsal joints. Hind tibia with several rather striking suberect stiff bristles on the outer hind side in addition to numerous smaller and more sloping bristles and hairs.

Wings dark brown, front calypters the same, the hind ones rather pale brown. Bend of fourth vein a little nearer the hind margin than usual, the distance being about two-thirds of that from the bend to the hind cross vein.

Described from 15 specimens of both sexes. Three males, including the type, are from Sapucay, Paraguay; the allotype and another pair are from Cavinas, Beni, Bolivia (Mulford Biological Exploration, collector W. M. Mann); six specimens were received from the American Museum of Natural History, collected at Chapada, Brazil (H. H. Smith), and one from East Amazonas; one from Guantanamo, Cuba (Ramsden), was received from C. W. Johnson; and one female from Yucatan (G. F. Gaumer) was received from the University of Kansas.

Length, 13.5 mm.

Type.—Male, Cat. No. 40480, U.S.N.M.

BELVOSIA ESURIENS Fabricius

Musca esuriens FABRICIUS, Syst. Antl., 1805, p. 301.

Tachina esuriens WIEDEMANN, Auss. Zweifl., vol. 2, 1830, p. 309.

Willistonia esuriens BRAUER and BERGENSTAMM, Zweifl. Kais. Mus., pt. 4, 1889, p. 97; pt. 5, 1891, pp. 349, 403; pt. 6, 1893, pp. 123, 204.

Belvosia esuriens ALDRICH, Proc. U. S. Nat. Mus., vol. 72, 1927, p. 32.

Male.—Front at vertex 0.31 of the head width; the eye rather broadly rounded above so that the narrow part continues forward from the ocelli, then rapidly widening; parafrontal with three very irregular rows of bristles inclined toward the center, the pollen gray, becoming very thin toward the vertex. Face and parafacials pure white, the latter somewhat silvery; hairs below the lowest frontals black, in certain lights two or three may have a pale reflection; cheek white pollinose and with white hairs among which three or four are black. Vibrissae almost the length of the second antennal joint above the oral margin; facial ridges with seven or eight strong bristles, the row almost reaching level of arista; third antennal joint three times the second, which is brown in color; palpi yellow.

Thorax black with thin gray pollen anteriorly; the scutellum subshining with a brown tinge. Calypters decidedly brown. Sternopleurals, 4.

Abdomen black, subshining; second segment with narrow basal band of light-yellow pollen; third segment with a distinctly interrupted band of almost white pollen covering a little more than the basal half and extending on the venter; fourth segment decidedly pollinose except the tip where the bristles arise, which is black; there is also a slender black median line scarcely interrupting the pale pollen. First and second segments with one pair of median marginals; third and fourth with a marginal row.

Legs black, the front claws and pulvilli elongated, the latter slightly longer than the last two tarsal joints. Hind tibia with several rather

large suberect bristles on the outer side on the upper half, the lower half with uniform row of smaller bristles. All these bristles stand along the outer side of some more depressed hairlike ones.

Wings rather light brown in color, narrow toward the apex, bend of fourth vein rectangular but rounded, a little nearer the margin of the wing than usual; base of third vein with three or four hairs.

Length, 11.5 mm.

Redescribed from a male specimen received from the Vienna Natural History Museum, which is apparently one of those which Wiedemann had before him when he redescribed *esuriens*. It is from Brazil, labeled "Coll. Winthem." and bears the small, square, red tag without writing which Brauer says indicates Wiedemann's original specimen. Wiedemann erroneously calls this specimen a female. Four additional specimens of this species, a male and three females, have been received from the American Museum of Natural History; they were collected at Chapada, Brazil, by H. H. Smith. The male has a longer third antennal joint and a narrower band on the third abdominal segment than the Vienna specimen, but the females are like the latter.

BELVOSIA WILLIAMSI, new species

Male.—Front at vertex 0.28 to 0.30 of head width, widening very slowly for a short distance. Parafrontals almost black except for a short distance anteriorly, where they are gray. Frontals in two irregular rows. Face, parafacials, cheeks, and orbits silvery white, the hairs below lowest frontals are black. Cheek with fine hairs which show a slightly reddish reflection. Antennae brown at base, third joint black, twice as long as the second. Facial ridges bristly to a little below the arista. Palpi yellow; beard white.

Thorax black, subshining, with a little gray pollen in front; scutellum more shining brown.

Abdomen shining black on the first two segments, the second with a faint trace of a basal pollinose line; third segment with a basal interrupted pale yellow crossband covering approximately one-half of the segment in the most favorable viewpoint, the remainder of the segment shining black; fourth segment with dense yellow pollen on the basal three-fourths, narrowly interrupted on the middle line; first and second segments with a single pair of median marginals; third and fourth with a marginal row.

Legs black, front pulvilli greatly enlarged, a little longer than the last two tarsal joints. Hind tibia rather evenly ciliated on the outer side with the usual larger bristle below the middle.

Length, 10.5–12 mm.

Described from three males. The type is from Campinas, Brazil, March, 1924 (F. X. Williams); one from Brazil without further datá; the other, received from C. H. Curran, is from Kartabo, British Guiana, 1924.

Type.—Male, Cat. No. 40483, U.S.N.M.

Named in honor of F. X. Williams, the collector.

BELVOSIA CANALIS, new species

Male.—Front at vertex 0.30 of the head width, not widening for a little distance. Parafrontals with distinctly yellowish pollen from the anterior part almost to the vertex, where the ground color begins to show dark. Frontals in two somewhat irregular rows. Face, parafacial, cheek, and orbit silvery pollinose. Hairs below the lowest frontals black, cheek with mostly pale hairs. Antennae black, third joint a little more than twice the second. Vibrissae rather high above the mouth, the distance being about equal to the second antennal joint. Facial ridges bristly almost to the arista; palpi yellow; beard white.

Dorsum of thorax subshining, more pollinose anteriorly; scutellum with brown pollen.

Abdomen deep black, not very shining on the first two segments; third segment with pale yellow basal pollinose band, covering almost half and interrupted on the middle line. Fourth segment with dense pale yellow pollen, covering all but the apical fifth and even here more or less distinctly visible in diagonal view. First and second segments of the abdomen with a single pair of median marginals, the hairs of the median region more upright than usual. Third and fourth segments with a marginal row of bristles. Venter with more soft hair than usual, but not so much as in *smithi*. Outer forceps black, strongly swollen in the basal and middle part, the tip thin.

Legs black, front pulvilli enlarged, as long as the last two tarsal joints; hind tibia coarsely ciliated, with two larger bristles near middle.

Wings and calypters brown.

Female.—Front 0.36 and 0.37 of head width at vertex. Parafrontals not with yellow color, rather plumbeous. Three pairs of proclinate orbital bristles.

Length, 11–12 mm.

Described from one male and two females; the male is from Barro Colorado Island, Canal Zone (Greene); the females from Campinas, Brazil, March, 1924 (F. X. Williams).

Type.—Male, Cat. No. 40484, U.S.N.M.

UNRECOGNIZED SPECIES

BELVOSIA OBESULA Van der Wulp

Cnephalia obesula VAN DER WULP, Biologia, Dipt., vol. 2, 1890, p. 46, pl. 3, fig. 3.

The original description is as follows:

Blackish; head white; frontal band, palpi, and base of the antennae rufous; scutellum testaceous; front margins of the abdominal segments with yellowish-

cinereous reflections, the anal segment wholly of that color; the abdomen somewhat transparent.

Length, 10.5 mm.

Face and sides of the front silvery-white; front much broader than the eyes; frontal band and vertex rufous; frontal bristles forming on both sides three rows, the inner row descending to the end of the second antennal joint; the bristles of the intermediate row shorter and weaker; oral margin not prominent; above the vibrissae are four bristles on the facial ridges; cheeks without black hairs; beard and pilosity of the occiput whitish; eyes bare, a row of short black bristles behind them. Antennae longer than in the preceding species; basal joints rufous; third joint black, with rufous base; second joint elongate, bristly; third joint twice as long as the second; arista indistinctly jointed, thickened to near the tip. Proboscis blackish; palpi rufous, thickened toward the end. Thorax blackish, before the transverse suture with whitish-grey tomentum and two black lines; pleurae greyish; scutellum testaceous. Abdomen short ovate, very convex; first segment black; second segment blackish, with grey reflections and a white front margin, laterally rufous, slightly transparent; third segment yellowish-grey, with brown reflections on the hind margin; anal segment short, pale ochraceous; macrochaetae as in the preceding species. Legs black; shorter and more robust than in *C. onusta*, but with similar bristles; foot-claws and pulvilli short. Tegulae white. Wings brownish-grey, intense yellow at the base; venation like that of *C. onusta.*

Hab. Mexico, Teapa in Tabasco (H. H. Smith).

A single female example.

Although it is clear that this species belongs to *Belvosia,* I have not been able to identify it in the material seen.

BELVOSIA ANALIS Macquart

Belvosia analis MACQUART, Dipt. Exot. Suppl., vol. 1, 1846, p. 160, pl. 14, fig. 4.—GIGLIO-TOS, Ditt. dell Mess., vol. 3, 1894, p. 29.

Originally described from Brazil, the type now presumably destroyed. Giglio-Tos identified a specimen from Tuxpango, Mexico, and Coquillett identified Mexican material as belonging to this species; but the original description says that the abdomen is blue, which seems to exclude it from this genus entirely, as none of the known species of *Belvosia* have this peculiar color. I have described Coquillett's species as *ciliata.*

BELVOSIA AURULENTA Bigot

Frontina aurulenta BIGOT, Annales Soc. Ent. France, 1888, p. 84.

Willistonia aurulenta BRAUER, Sitzungsber. Kais. Mus., vol. 106, 1897, p. 356.

The type is a female from Brazil, and has been examined by Brauer, who referred it to *Willistonia.* I do not find either in his remarks or in the original desciption the necessary characters to connect the name with any of my species.

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THE SCORPIONS OF THE WESTERN PART OF THE UNITED STATES, WITH NOTES ON THOSE OCCURRING IN NORTHERN MEXICO

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INTRODUCTION

During recent years many inquiries have been received in regard to the identity, habits, and the seriousness of the stings of our scorpions. Most of these have come from the Southwestern States where scorpions are abundant and where the activities of the people bring many of them in frequent contact with these venomous arachnids. Scorpions in this section of the country are a great annoyance. Although serious cases of stinging have been few there, across the border in northern Mexico many reports of serious consequences following scorpion stings have been made. In the State of Durango even death has been attributed to them. Because of these inquiries and reports it was decided to investigate especially the scorpions of the Southwest. This paper is the first to be prepared dealing with them. In it a taxonimic synopsis is given of all the species reported from the United States west of the Mississippi River. In dealing with the more common species the distribution, as far as known up to the present, has been given. Although but little has been learned of the life histories, habits, and effects of the venom of most of our species, that which is known is summarized. More complete revisionary papers dealing with the taxonomy and literature of the species occurring in North America are planned.

Notes are frequently added concerning species occurring in northern Mexico. These are of particular value since the writer has had the opportunity of studying a large collection of scorpions taken in Durango, Mexico and some other localities in that country by Dr. W. J. Baerg, of the University of Arkansas. Also it is of much importance to know if the species which are being reported as being fatal to man in Durango occur within our borders and if so to what extent and under what conditions.

Before attempting the present synopsis the writer was sent by the Bureau of Entomology to the States of Louisiana, Texas, and Arizona to investigate scorpion conditions and make collections. While there something was learned of the habits of scorpions and of man's encounters with them; also many live specimens were captured. Various persons in the Southwest aided the writer in securing information and in collecting specimens. Special mention should be made of the following: Mr. E. V. Walter, Bureau of Entomology, San Antonio, Tex.; Mr. H. B. Parks, apiculturist, State Apicultural Research Laboratory, near San Antonio, Tex.; Mr. V. L. Wildermuth, Bureau of Entomology, Tempe, Ariz.; Mr. E. E. Russell, Bureau of Entomology, Yuma, Ariz., and several members of the Bureau of Entomology staff at Dallas, Tex.

CONCERNING SCORPIONS IN GENERAL

Scorpions are large, more or less crablike, arachnids of very ancient origin. By leading authorities they are considered as the most ancient and generalized of the true arachnids. They have the body divided into two definite regions, the cephalothorax and the abdomen. The latter, however, has the posterior part greatly narrowed and formed into a so-called "tail." This region, known as the postabdomen, bears on its distal segment the sting, the only weapon which the scorpion has to make itself dreaded by man.

The legs of a scorpion are eight in number throughout life. They are clawed at the end and are all similar. The palpi are greatly enlarged, and the last two segments form a powerful pinching structure known as the chelae. The true jaws, which should be known as the chelicerae, are much smaller structures than the chelae and are partly concealed from above by the front edge of the carapace, the hard covering of the cephalothorax.

The organs of special senses are poorly represented; however, the eyes are conspicuous and of two kinds. There is a pair of large eyes situated on the sides of a turret or tubercle near the middle of the dorsal surface of the cephalothorax and several smaller eyes, or ocelli, situated on the lateral margins. The more important structures used in taxonomy are given in the accompanying illustration.

Scorpions are found in greatest abundance in tropical and subtropical countries. Only a few species range far into the temperate zones and none extend across either of these zones. The taxonomic work on the United States species has been done chiefly by Wood, Marx, and Banks. In the past 20 years no extended paper has appeared dealing with our species. The subject of the control of scorpions and of the treatment of their stings will be dealt with in a subsequent paper.

But four families of scorpions occur in the United States and northern Mexico. These may be separated as follows:

KEY TO THE FAMILIES OF SCORPIONS OCCURRING IN WESTERN UNITED STATES AND NORTHERN MEXICO

A[1]. Sternum subpentagonal, with sides almost parallel.
B[1]. Membrane at base of last tarsal segment of most of the legs with a single spur; postabdomen frequently reduced---------------**Scorpionidae.**
B[2]. Membrane at base of last tarsal segment of most of the legs with two spurs.
C[1]. Only two ocelli on each lateral margin of carapace------Chactidae.
(Only one genus, *Broteas*, in United States and Mexico.)
C[2]. With 3 to 5 ocelli on each lateral margin of carapace-----Vaejovidae.
A[2]. Sternum triangular, the sides being strongly convergent anteriorly; membrane at the base of last tarsal segment of most of the legs with two unbranched spurs; fixed arm of chelicerae without ventral tooth.
Buthidae.

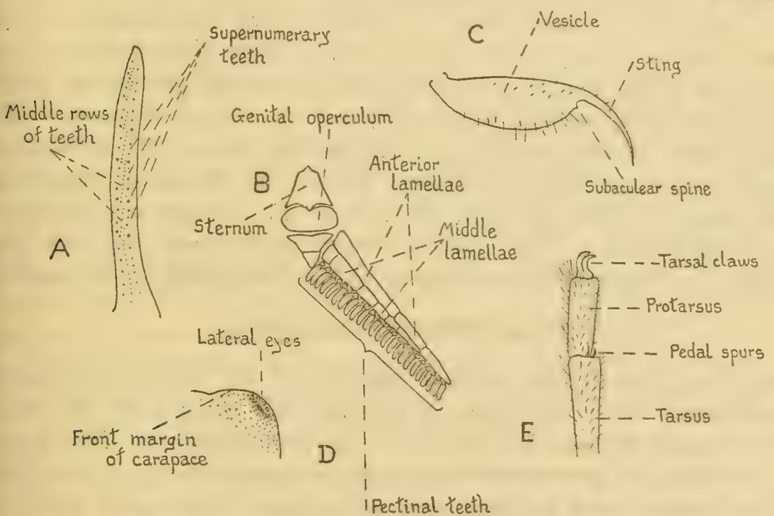

FIG. 1.—DETAIL DRAWINGS OF PARTS OF CENTRUROIDES VITTATUS SAY TO ILLUSTRATE STRUCTURES OF TAXONOMIC IMPORTANCE: A, FINGER OF CHELICERA; B, LEFT HALF OF STERNAL REGION OF MALE; C, CAUDAL SEGMENT OF MALE; D, ANTERO-LATERAL SECTION OF CARAPACE; E, LAST TWO SEGMENTS OF LEG IV

Family SCORPIONIDAE

In this family the sternum is subpentagonal in shape, the sides being almost parallel. The membrane at the base of the last tarsal segment of most of the legs bears a simple spur. The postabdomen is usually somewhat, or even decidedly, reduced.

The family is well represented in Central America and the tropical regions of the Old World but is poorly represented in the central part of South America and in the United States. Dr. de Mello Campos (1924) mentions only a single species as occurring in Brazil, and but

three species are known from the United States. Our two subfamilies and two genera may be separated as follows:

KEY TO THE SUBFAMILIES AND GENERA OF THE FAMILY SCORPIONIDAE OCCURRING IN THE UNITED STATES

A[1]. No spine or tubercle under the sting on caudal vesicle.
Subfamily Ischnurinae.

Only a single genus represented in the United States.
Opisthacanthus Peters.

A[2]. A spine or tubercle under the sting near its base__Subfamily Diplocentrinae.

Only a single genus represented in the United States.
Diplocentrus Peters.

Genus OPISTHACANTHUS Peters

In *Opisthacanthus* the pedipalps are very large, and the postabdomen is reduced and compressed. The carapace is deeply emarginate in front and has a median groove for the entire length. There are three ocelli on each side. The tarsi have two ventral rows of small spines. The pectines are short, with only a few teeth.

Formerly this genus included species occurring in tropical Africa and Madagascar as well as those found in tropical America. Now the African species are placed in a distinct genus. We have but a single representative, *O. lepturus* Palisot de Beauvois, which has been reported from Florida. Formerly this species was known as *O. elatus* Gervais. The species occurs in Panama and the West Indies. Records of its occurrence in Mexico appear to be wanting.

Genus DIPLOCENTRUS Peters

In *Diplocentrus* the anterior margin of the carapace is deeply emarginate; there are three ocelli on each side; and the ocular tubercle is in front of the middle of the cephalothorax. The fingers of the chelae are provided with a close-set longitudinal series of teeth and a lateral series on each side of scattered teeth some being enlarged. The fifth segment of the postabdomen has a ventral semicircular area bounded by a row of granules. The sting is provided with a basal tubercular tooth.

The genus is found throughout most of tropical America. Dr. de Mello Campos (1924) records a single species from Brazil. Three species occur in the United States, two in the Southwest and one in Florida. The southwestern species may be separated as follows:

KEY TO THE WESTERN UNITED STATES SPECIES OF DIPLOCENTRUS

Color very dark reddish brown, almost black; length from 5 to 7 cm.; pectinal teeth 14____D. whitei (Gervais).

Color reddish brown but not approaching black; length from 4 to 5.5 cm.; pectinal teeth 9–11__________________________________D. keyserlingi Karsch.

DIPLOCENTRUS WHITEI (Gervais)

D. whitei is a very dark reddish brown scorpion, from 5 to 7 cm. in length, with large stout chelae and short fingers. The sting is scarcely half as long as the vesicle that bears it and is strongly curved. The subaculear tooth is large and shaped like a tubercle. The caudal vesicle bears several long setae distally.

Although the type specimen of this species came from Mexico, according to Pocock (1902): "No exact locality in Mexico has ever been assigned to specimens of this species." Pocock further states that the "example in the British Museum is the type of the species, which is dried and too imperfect to be available for description." In the United States National Museum there are only two specimens. They were taken on the Mohave Desert, Calif. The description and figures given by Pocock (1902) were from an adult male and female taken at San Diego, Tex. In the Baerg collection there is a single adult specimen taken at Tlahualilo, Mexico.

The writer has been inclined to associate serious scorpion stinging with this species. The descriptions of scorpions given by a number of people living near the Mexican boundary, involved in serious stinging cases, apply best to this species, although all descriptions given have been devoid of that exactness demanded in scientific taxonomy as being necessary for identification. Most individuals interviewed insisted upon the scorpions with the "deadly" sting being "black" ones, and that they were not the big light-colored species and were not the smaller striped ones. Speculation, however, upon hearsay evidence is a hazardous procedure. What is needed is experimental demonstration. Unfortunately this scorpion is seldom taken alive. I have seen none in a wild state.

DIPLOCENTRUS KEYSERLINGI Karsch

This scorpion is very similar to *D. whitei* but is smaller and of a lighter color and has not more than 11 teeth in the pectinal comb, while *D. whitei* has 14. Also the carapace is more granulate than in *D. whitei*.

Comparatively little is known concerning the distribution of this species. Pocock gave but two records for it, both from Mexico. Banks (1910) reports it from California, stating that there are specimens in the Marx collection labeled "California." The specimens referred to, which are said to be "nearly black" are probably those marked "*Diplocentrus venustus*." These large very dark specimens have from 10 to 12 teeth in the pectines, and may prove to be either a new species or a variant of *D. whitei*. Specimens in the National Museum from Paisano, Tex., determined as *D. whitei* should be considered as *D. keyserlingi*. In the Baerg collection there are

two large specimens from Durango, Mexico, and six smaller ones (including some that are evidently immature) from Atotonilco, Mexico.

It would be of much importance to experiment with this species to see if it could be implicated in any way in the serious cases of scorpion stinging reported from Durango, Mexico.

Family CHACTIDAE

The family Chactidae differs from our other American scorpion families in having only two ocelli on each side of the carapace. The sternum has straight, but slightly converging sides and an outwardly angulate anterior margin. It is as long as, or longer than broad.

The family has a wide distribution in the world but is wanting in the Ethiopian and Australian regions. Kraepelin (1905) lists four genera and 29 species for the Neotropical Region, all of which are characteristic of this region. In the United States but a single genus and species is found.

Genus BROTEAS Koch

In the genus *Broteas* the latest tarsal segment bears two rows of short spines on the under surface. Segments I–IV of the postabdomen are keeled below and the stigmata are slitlike. Only one species occurs in the United States.

BROTEAS ALLENI (Wood)

ALLEN'S SCORPION

This is a small dark-brown species. The hands are slightly keeled and swollen; the fingers are very short, being but little over one-half as long as the hand. The small, slender tail has the vesicular segment depressed; the sting broadens out proximally into the vesicle. A National Museum specimen measures 3 cm. in length.

This species occurs, as far as known, only in the extreme southwestern part of North America. The type was taken at Cape San Lucas, Lower California. There are two specimens in the National Museum collection, both from Fort Tejon, Calif. These two records are the only ones known to the writer, hence it is assumed that the species is rare. Its habits are unknown.

Family VAEJOVIDAE

Members of the family Vaejovidae have the sternum subpentagonal, the sides being subparallel. There are two spurs on the membrane at the base of the last tarsal segment, and from three to five

ocelli on each side of the cephalothorax. This family is rather closely related to the family Chactidae, but differs from it in having more than two ocelli on each side of the cephalothorax.

The family is best represented in North and Central America, but also occurs in the northern part of the Old World and in South America. Dr. de Mello Campos (1924) does not mention it in his synopsis of the Brazilian scorpions. The four genera found in the United States may be separated as follows:

KEY TO THE GENERA OF VAEJOVIDAE OCCURRING IN THE UNITED STATES

A^1. Middle area of pectines broken up into more than eight small pieces, the most of which are subcircular; first four segments of postabdomen without single ventral keel.

B^1. Movable finger of chelicera with a spinelike tooth on the lower surface. Large hairy scorpions____________________________Hadrurus Thorell.

B^2. Movable finger of chelicera without ventral tooth______Vaejovis Koch.

A^2. Middle area of pectines more or less indistinctly broken up into seven or less pieces.

B^1. Divisions of middle area of pectines unequal and few in number; sting sometimes bulbous near base___________________Anuroctonus Pocock.

B^2. Most of the divisions of the middle area of pectines subequal and numbering over five; sting normal__________________Uroctonus Thorell.

Genus HADRURUS Thorell

In *Hadrurus* the middle area of the pectines is broken up into more than eight small pieces, those toward the distal end being very small and subcircular. The first four segments of the postabdomen, or cauda, are without the single median keel. The movable finger of the chelicera has a spinelike tooth on its lower surface.

This genus includes only a few North American species. One species and a variety occurs in the southwestern part of the United States and another species in Mexico. These may be separated by means of the following key:

KEY TO THE NORTH AMERICAN FORMS OF HADRURUS

A^1. Length over 70 mm.; body reddish brown; appendages and postabdomen very hairy; number of teeth in pectines 34 to 40.

B^1. Frontal space of carapace finely granular; hand and brachium finely and closely granular; movable finger longer than carapace. H. hirsutus Wood.

B^2. Frontal space of carapace sparsely studded with large round granules; hand and brachium smooth except on crests; movable finger shorter than carapace___________________________________H. aztecus Pocock.

A^2. Length not over 60 mm.; body olive gray; appendages and postabdomen less hairy; number of teeth in pectines 25 to 32. H. hirsutus var. arizonensis, new variety.

HADRURUS HIRSUTUS Wood

GIANT HAIRY SCORPION

This species (pl. 1, fig. 1) is our largest and most distinctive species. The region in front of the ocular tubercle is very white and in live specimens shows up in sharp relief the lateral ocelli giving the scorpion the appearance of having a face. The body as a whole is a dark yellowish or reddish brown. The appendages and the post-abdomen are very hairy, hence the name *hirsutus*. Some of the alcoholic specimens in the National Museum collection measure over 11 cm. in length. Many spec mens are much smaller, and in desert situations they are scarcely more than half this size. These, however, should be regarded as a distinct variety.

This large arachnid is found in many places in southwestern United States and northwestern Mexico. National Museum specimens are from Nevada, Arizona, and California, in the United States, and Sonora and Lower California, Mexico. Pocock (1902) questionably reports the species from Guatemala and mentions "two smaller examples for which no locality is known," which probably should be referred to the variety to be described farther on in this paper. The writer obtained a live overwintering female specimen of this species at Tucson, Ariz., March 27, 1927, and has kept her in captivity up to the time of writing this paper, July, 1927. Between April 27 and May 19 she ate three large roaches, two being adults of *Periplaneta americana*. Since that time she has refused to eat. The specimen at once excavated a pit in the earth at the bottom of the breeding cell and occupied it at all times afterward.

HADRURUS HIRSUTUS, var. ARIZONENSIS, new

In the desert regions about Phoenix and Tempe, Ariz., there occurs a scorpion that should be regarded as only a variety of *hirsutus*. It is smaller, less hairy, and the color of the appendages and legs is a light yellowish, while the abdomen is almost black.

Length, varying from 4 to 7 cm.

Type locality.—Papago Saguaro National Monument, Ariz.

Type.—Cat. No. 971, U.S.N.M.

Four specimens obtained, all by the writer; three, including the type, from under stones, Papago Saguaro National Monument, Ariz., March 31, 1927, and one (kept alive) from Tempe, Ariz., March 29, 1927.

This live individual was taken from under a stone in a rocky place at Tempe, Ariz. It was a female specimen much distended, apparently with developing eggs. She was placed in a museum jar and carried about all the way to the Pacific coast and back to Washington, D. C. On April 26 I arrived at Washington and placed her

in a jar with a deep layer of soil at the bottom and a small piece of wood inclined against one side of the jar. The idea in placing the wood in the jar was to give the scorpion a place to conceal itself as it normally does in nature. One edge of the wood, however, was lifted enough to allow easy vision of the specimen when the jar was held to the light.

During the very first day the scorpion started digging in the sandy soil. This was accomplished by sudden backward jerky movements of one or two legs on a side at a time. The first and second or the second and third legs of a side were most frequently used. After a considerable amount of excavation had been made she remained comparatively quiet in the hole under the wood. Although offered several roaches as food, none were eaten. During the latter part of May she came out from under the piece of wood and did not return until she had dug a tunnel similar to those of gophers. Inside of this tunnel she rested contentedly. This specimen, as well as others kept in captivity, at first showed much activity during the night. When the lights were turned on the scorpion would be found scrambling up the sides of the jar, lifting itself as high as possible by the cauda, then falling back again.

HADRURUS AZTECUS Pocock

MEXICAN HAIRY SCORPION

Pocock (1902) described as new a species taken at Jalapa, Mexico. In general appearances it is almost exactly like the well known *H. hirsutus* of the Mexican border, but differs from the latter in a number of minor characters. In *aztecus* the frontal area of the carapace is studded with large round granules instead of being closely and finely granular; the terga are mostly smooth in front and mesially instead of being finely and coarsely granular as in *hirsutus*. There are several other differences.

The distribution and habits of this species have not been studied. There are no specimens of it in the United States National Museum, and it is not represented in the Baerg Mexican collection.

Genus VAEJOVIS Koch

Vaejovis is similar to *Hadrurus* but is easily distinguished from the latter by the absence of the spinelike tooth on the ventral side of the movable finger of the chelicerae.

The species of *Vaejovis* are smaller than those of *Hadrurus* and, with but a single exception in the United States, are much less hairy. In this genus is to be found a majority of the North American members of the family Vaejovidae. One of its species far outranges all other scorpions to the northward in America being found up to, or possibly over, the northern boundary of the United States.

KEY TO THE UNITED STATES SPECIES OF VAEJOVIS[1]

A¹. Hands provided with ridges or keels and granular.
  B¹. Caudal vesicle densely beset with long hairlike setae, some of which equal the sting in length—————V. hirsuticauda Banks.
  B². Caudal vesicle practically bare.
    C¹. Ventral keels distinct on all the segments of postabdomen; sting about as long as the vesicle from which it arises.
      D¹. Second and third segments of postabdomen longer than broad.
        E¹. Middle dorsal keel hand well developed, as prominent as the others; sting curved throughout and a little longer than the vesicle that bears it——V. punctipalpis Wood.
        E². Middle dorsal keel of hand obsolete; sting curved distally and shorter than vesicle——V. yosemitensis, new species.
      D². Second and third segments of postabdomen broader than long. V. minimus Kraepelin.
    C². Ventral keels on first two segments of postabdomen vestigial or wanting; sting not over two-thirds as long as the vesicle from which it arises.
      D¹. Integument smooth or finely granular. A light yellowish brown or greenish species—————V. boreus Girard.
      D². Integument coarsely granular. A dark reddish brown species. V. mexicanus Koch.
A². Hands without keels and smooth.
  B¹. Segments IV and V of postabdomen stouter than those in front of them; color greenish or yellowish, with broad, indistinct, yellowish, median stripe on dorsum of abdomen and 4 dark longitudinal lines on under side of postabdomen—————V. spinigerus Wood.
  B². Segments IV and V of postabdomen scarcely as stout as those in front of them.
    C¹. Hand slender, not swollen on inside, about twice as long as wide. Western species—————V. flavus Marx
    C². Hand not slender, markedly swollen on inside, about one and a half times as long as wide.
      D¹. Segments III and IV of postabdomen without ventral submedian keels. Eastern species——V. carolinianus Beauvois.
      D². Segments III and IV of postabdomen with ventral submedian keels. Western species————V. subcristatus Pocock.

VAEJOVIS HIRSUTICAUDA Banks

Banks (1910) has described a scorpion of this genus with a very hairy tail. It is reddish brown, very granular, with a slender and very strongly keeled postabdomen, the vesicle of which is brushy because of the large number of hairlike setae it bears. The length is about 31 mm. It was taken in San Bernardino County, Calif.

VAEJOVIS PUNCTIPALPUS Wood

V. punctipalpus is a long species, larger specimens being 6 cm. in length, with a well developed postabdomen. The hands are stout and keeled. It is of a uniform reddish brown color.

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[1] The species described by Borelli as *V. silvestrii* is not included in this key, as its status is somewhat in doubt.

This species occurs in the southwestern part of the United States and the northwestern part of Mexico. In the National Museum collection there are specimens from Utah, Nevada, California, New Mexico, and Lower California. Essig (1926) reports it also from Arizona.

VAEJOVIS YOSEMITENSIS, new species

YOSEMITE SCORPION

As far as known only a single species of scorpion occurs in the Yosemite Valley. This species (pl. 2, fig. 3) was taken during the spring of 1927 under the rocks at the base of the Yosemite Falls. Here, and only here, in a perpetual fog of spray from the falling waters of one of the world's highest cataracts, could specimens be obtained. Just why such a situation was so well suited to the species is hard to understand. Usually scorpions prefer much hotter and drier places. The technical description follows:

General color reddish brown, with the finger of the pedipalps and the abdomen proper darker than the rest. Hands stout and well keeled, the inner dorsal keel continues almost to the tip of the fixed finger, the outer dorsal keel ends with the hand, middle keel reduced, obsolete, but darkened with pigment. Fingers strongly upcurved and equal to the hand in length. Carapace with broad deep anterior marginal notch, deep median groove and granular surface. Abdomen uniformly colored above. Pectinal comb reaching to the sides of the abdomen, with 14 teeth and 10 to 12 pieces in middle area. Postabdomen longer than abdomen proper, ventral keels strongly tubercular and on all segments except the caudal vesicle. Sting much less in length than the vesicle, almost straight at the base and very broad. It is black at the tip but of the same color as the vesicle at the base.

Total length, 40 mm.; length of postabdomen, 23.5 mm.; greatest width of carapace, 7.4 mm. (measurements made from fresh alcoholics).

Type locality.—Yosemite Valley, Calif.

Type.—Cat No. 972, U.S.N.M.

Description based on three specimens taken during April, 1927, by Dr. Fred Ewing and the writer on the ground under rocks at the base of Yosemite Falls. One of these was a young specimen. It was taken on April 14th. The other two were adults and were taken on the 15th.

VAEJOVIS MINIMUS Kraepelin

Kraepelin (1911) described a small species of *Vaejovis* from San Pedro, Calif. In this species the upper side of the body is reddish brown and the under side, as well as the legs, is yellowish. The postabdomen is very short, each of the first three segments being broader

than long. There are 10 teeth in the pectinal comb in the male and 9 in that of the female. Nothing is known of the habits or distribution of the species.

VAEJOVIS BOREUS (Girard)

NORTHERN SCORPION

This scorpion (pl. 1, fig. 2), the most northern in its distribution of any American species, is unmarked and dark yellowish brown. In length it varies from 3.5 to 5 cm., and is of slender proportions. The sting has a broad base which expands imperceptibly into the vesicle.

Webster (1923) reported the species as occurring in North Dakota in the region known as the "Bad Lands." His specimens were identified by the writer. Chamberlin (1924) identified a specimen of this species taken at Medicine Hat, Alberta, Canada. It is not known for sure, however, that *V. boreus* is actually established in Alberta. Scorpions are constantly found under artificial conditions far north of their natural range, where they have been transported by shipments of household goods, fruit, lumber, or other materials. Such specimens have been determined by the writer from Washington and Philadelphia. It is well known, however, that in a state of nature scorpions are not found in the environs of either of these two cities. In the National Museum there are specimens from the following States: Arizona, Nebraska, Oregon, Idaho, Wyoming, Montana, South Dakota, and North Dakota. It is believed that this material indicates fairly well the natural distribution of the species.

Nothing is known concerning its habits other than the situations in which they are found, which are those common to most scorpions.

VAEJOVIS MEXICANUS Koch

MEXICAN VAEJOVIS

This scorpion is dark, reddish brown and is very granular. The postabdomen is large, the vesicle rather slender and the sting short. There are no ventral keels on the first two segments of the postabdomen. Length about 4.5 to 5.5 cm.

The species is probably the most widely distributed of any in Mexico occurring from Mexico City to the southwestern part of the United States. In the mountainous regions of Mexico it breaks up into two distinct subspecies, *dugesi* Pocock and *smithi* Pocock. In the National Museum collection there is but a single specimen which was taken at Eagle Pass, Tex. In the Baerg collection there is a specimen from Durango, Mexico, and two from Guatimape, Mexico.

VAEJOVIS SPINIGERUS (Wood)

STRIPED-TAILED SCORPION

This species (pl. 2, fig. 4) is easily recognized from the others occurring in the region where it is found by its large size and the presence of four longitudinal dark stripes on the under side of the "tail," or postabdomen. It varies in length from about 5 to 8 cm. and is rather stout-bodied and is exceeded in size in the Southwest only by *Hadrurus hirsutus* (Wood) (pl. 1, fig. 1), a hairy species of a different genus.

Its home is the desert region of the Southwest where it has been reported from Texas to California. The type specimens were taken in Texas. This species must range far into northern Mexico, but it is not represented in the Baerg collection from the State of Durango.

It is found particularly in rocky waste places where there is some moisture. However, during the spring of 1927 the writer took two adults under a large rock at a street corner in the center of the town of Tempe, Ariz. It is the most common scorpion in the Papago Saguaro National Monument, in the Salt River Valley, Ariz. At Yuma, Ariz., a persistent search for it by the writer failed in locating specimens. However, on May 4, 1927, E. E. Russell, of the Bureau of Entomology, took three specimens here along the reclamation levee and railroad track. A few years ago the writer determined a number of specimens of this species from southern New Mexico, for Dr. W. J. Baerg.

Baerg (1924) allowed this species to sting him and reported the results as follows:

"The sensation was very much like that of a pin prick, and the resulting pain, which was very slight, lasted scarcely half an hour. There was no white area around the punctures and not the slightest swelling or inflammation."

VAEJOVIS FLAVUS Marx

This yellowish species is probably our most slender representative of the genus. The pedipalps are particularly weak and slender and the hands smooth and without keels. The fourth and fifth segments of the postabdomen are scarcely as stout as those in front of them.

The species occurs in the arid Southwest, but is rarely encountered. Two specimens are in the National Museum, one from Albuquerque, N. Mex., and one from "Fort Yuma," Ariz. Records from Mexico appear to be wanting. The species doubtless occurs in that country near the United States border.

VAEJOVIS CAROLINIANUS Beauvois

SOUTHERN UNSTRIPED SCORPION

Besides the common striped scorpion, *Centruroides vittatus* (Say) (pl. 2, fig. 5), there is another scorpion species somewhat smaller that is found in many of the Southern States. This species, *V. carolinianus*, is unmarked, of a dark reddish brown, with a large postabdomen and rather slender pedipalps. A museum specimen measures slightly over 4 cm. in length.

The species ranges from South Carolina to Texas. In the National Museum collection there are specimens from Alabama, Georgia, and Kentucky. Little is known about the habits of this species.

VAEJOVIS SUBCRISTATUS Pocock

This Mexican scorpion is of medium size (length 5.15 cm. male, 5.20 female, according to Pocock) and has the body mottled above with reddish yellow and blackish brown. The first two segments of the abdomen are broader than long. Pocock (1902) reports it from San Andres and Jalapa, Mexico. The only United States record that the writer has found for this species is by Borelli (1909), who reports two young females from Tucson, Ariz., taken by Professor Silvestri.

VAEJOVIS SILVESTRII Borelli

Borelli (1909) described as new a scorpion taken by Silvestri in the Sierra Madre Mountains, Southern California. This appears to be the only scorpion taken by this collector in a region rich in described species. The species can not be satisfactorily placed, and may be a synonym of one of the several species of *Vaejovis* known from this region.

Genus ANUROCTONUS Pocock

In *Anuroctonus* the middle area of the pectines is broken up, sometimes in an indistinct manner, into seven or less pieces; and these divisions are unequal. The sting is sometimes bulbous near the base. But one species of the genus is known from the United States and northern Mexico.

ANUROCTONUS PHAIODACTYLUS (Wood)

SHINY-STINGED SCORPION

Not only has this scorpion a shiny sting, but a most peculiarly shaped one. Between the tip of the sting and the base, but nearer the latter, there is an inflated, bulbous structure. Probably the term "swollen-stinged scorpion" or "bladder-stinged scorpion" would be equally appropriate with the one given at the heading of this para-

graph, which was originally suggested by Essig. This scorpion is from 5 to 6 cm. long, with a reduced postabdomen but a very large vesicle. The pedipalps are stout and the fingers short and strongly curved. These are black, while the remainder of the scorpion is a reddish brown.

The shiny-stinged scorpion has a wide distribution. Pocock (1902) reports it from Virginia, Colorado, Utah, California, and Guatemala. The first of these records, however, should be questioned. The species probably does not occur in a state of nature in eastern United States. National Museum specimens are from Utah and California.

Genus UROCTONUS Thorell

Uroctonus differs from *Anuroctonus* in the nature of the divisions of the middle area of the pectines. This area is broken up into over five pieces, the most of which are subequal. Only a single species is reported from United States and northern Mexico.

UROCTONUS MORDAX Thorell

MORDANT SCORPION

The mordant scorpion has large pedipalps and stout hands, while the "tail" is somewhat reduced. The sting is but slightly curved, except toward its tip. It is a dark-brown species, the carapace and pedipalps being darker than the abdomen, and the abdomen in turn is darker than the legs.

U. mordax is a Pacific coast species, being reported from California and Oregon. Banks (1910) reports it from nine localities in California, including one record from Santa Rosa Island. Borelli (1909) reports it from Oregon. In the National Museum collection there are four lots of specimens, all from California. The habits of the species have not been studied.

Family BUTHIDAE

The family Buthidae is at once distinguished from our other American families of scorpions by the shape of the sternum. The sternum is triangular, the sides being strongly convergent anteriorly. The membrane at the base of the last tarsal segment of most of the legs has two unbranched spurs. The fixed arm of the chelicerae is without a ventral tooth.

The family Buthidae is the most widely distributed of all the families of scorpions. It is the only family to be represented in each of the six chief zoogeographical regions. Not only is it found in all these regions, but from several to many species are found in

each of them. Kraepelin (1905) gives the number of genera and species for the zoogeographical regions as follows:

	Genera	Species
Ethiopian	11	95
Palaearctic	5	62
Oriental	8	45
Australian	3	8
Nearctic	2	22
Neotropical	4	61

Four genera are now known to occur in the United States. They are keyed out as follows:

KEY TO THE GENERA OF BUTHIDAE OCCURRING IN THE UNITED STATES

A[1]. First tarsal segment of legs III and IV with a distal spur...Uroplectes Peters.
A[2]. First tarsal segment of leg IV without distal spur.
 B[1]. Oblique rows of teeth on fingers of chelae flanked with supernumerary rows of teeth...Centruroides Marx.
 B[2]. Fingers of chelae without flanking supernumerary rows of teeth.
  C[1]. Most of oblique rows of teeth on fingers of chelae overlapping. Tityus Koch.
  C[2]. Rows of teeth on fingers of chelae not overlapping. Isometrus Hemprich and Ehrenberg.

Genus UROPLECTES Peters

Uroplectes differs from our other genera of Buthidae in having a distal spur on the first tarsal segment of legs III and IV. It is a genus that belongs to the Old World, our species apparently being an introduction.

UROPLECTES MEXICANUS Comstock [2]

MEXICAN UROPLECTES

Under this name Comstock (1912) describes a species as follows: "This is a pale species. There is no spine under the sting; the teeth on the finger of the palpus are in many oblique rows, with stouter teeth at the end of each and to one side; there are from 30 to 35 teeth in the combs; and the keels on the under side of the last caudal segment are very strongly toothed."

He writes that the species has been found in Texas and California. Kraepelin (1905) is of the opinion that this scorpion probably was introduced from the Old World. Banks (1910) does not include it in his list of California scorpions. There are no specimens of American *Uroplectes* in the National Museum collection.

[2] Comstock's 1912 description is the first for this species. He appears to have used Banks's manuscript name *Uroplectes mexicanus*.

Genus CENTRUROIDES Marx

In *Centruroides* the first tarsal segment of leg IV is without a distal spur; the teeth of the fingers are arranged in oblique rows with supernumerary rows on each side. This genus is exclusively American, but in this continent has a wide range, being found from Central United States to Chile. Many species are included in it. A key is here given to those of the western part of our country.

KEY TO THE CENTRUROIDES OF WESTERN UNITED STATES

A^1. Length over 8 cm.; body unstriped. Large dark species.
- B^1. Fingers of hand furnished with nine middle rows of teeth, exclusive of short apical row ---------- C. nigrescens Pocock.
- B^2. Fingers of hand with only eight middle rows of teeth, exclusive of short apical row ---------- C. margaritatus (Gervais).

A^2. Length less than 7 cm. Reddish brown or striped species.
- B^1. Sting without ventral spine or tubercle near base; fingers one and a half times as long as hand ---------- C. exilicaudata (Wood).
- B^2. Sting with a ventral spine or tubercle.
  - C^1. Abdomen with two more or less interrupted longitudinal stripes above; sting with a spinelike tubercle below.
    - D^1. Black stripes irregular but never appearing as a row of dots. Eastern species ---------- C. vittatus (Say).
    - D^2. Black stripes partly or entirely interrupted at each body segment so as to appear as a row of spots. Found in California ---------- C. californicus (Girard).
  - C^2. Abdomen without longitudinal stripes; sting with a vestigial tubercle below; dorsal surface of abdomen very rough. C. sculpturatus, new species.

CENTRUROIDES NIGRESCENS (Pocock)

BLACK SCORPION

C. nigrescens is a large, long, black scorpion. The color varies from a very dark chestnut brown to a jet black. The appendages are slender, the fingers being about one and a half times as long as the hand. The postabdomen is much longer than the abdomen. The sting is very long and curved with a sharp subaculear tubercle. A large National Museum specimen measures 10 cm. in length.

Pocock (1902) reports this species from Xautipa and Amula in Guerrero, Orizaba, Mexico. Borelli (1909) does not mention it in his list. Banks (1910) does not give it in his list of California scorpions. In the National Museum collection there are two specimens from Eagle Pass, Tex., and one from San Antonio, Tex. H. B. Parks, apiculturist at the state apicultural research laboratory, a few miles south of San Antonio, Tex., told the writer that he is familiar with a large, black scorpion the description of which fits this species. While collecting scorpions at San Antonio the writer did not see any examples of the species.

CENTRUROIDES MARGARITATUS (Gervais)

C. margaritatus is similar in general appearances to *C. nigrescens*, but has one less row of teeth in the middle series on the fingers, and the basal segments of the postabdomen and the legs are lighter in color than the body. Male specimens measure as much as 10 cm. in length.

This is a widely distributed species occurring in America from the southern United States to Brazil and Chile and, according to Pocock, is found in West Africa. Comstock (1912) reports it from Florida. Pocock (1902) states that there are specimens in the British Museum from California. Banks (1910) does not include it in his list of California scorpions. Specimens from the United States are wanting in the National Museum. According to Baerg (1925) this species is the one most commonly met in the Panama Canal Zone.

Baerg (1925) experimented with this species, inducing it to sting white mice and himself. The effect on the mice was not serious, and the bitten area showed no inflammation or other effect. When the scorpion stung Doctor Baerg there was a severe pain at first and the affected area was reddish. No permanent effects were produced. Baerg reports the experiences of two scientists who were stung by this species. In these cases there was considerable swelling produced and in one case some lameness in the tongue.

CENTRUROIDES EXILICAUDATA (Wood)

SLENDER-TAILED CENTRUROIDES

This scorpion not only has a slender tail, or postabdomen, but also slender appendages. The fingers of the hand are very slender, being about one and a half times as long as the hand proper. In the male the postabdomen is almost twice as long as the abdomen. There is no vestige of a tooth or tubercle under the sting. The absence of this tooth alone distinguishes this species from all other United States species of its genus. A male specimen in the National Museum collection measures 5.1 cm. in length.

This species was orginally described from Lower California, the type specimens being in the National Museum. Also in the National Museum there are a number of specimens from Lower California, most of them coming from Cape San Lucas, but there are two specimens coming from San Diego, Calif.

According to Jackson (1910) the stings of this species may prove fatal to man. In fact he attributes many deaths to it in the State of Durango, Mexico. It is possible in this connection, however, that the species involved was not *C. exilicaudata*, as I do not find it in a large collection of scorpions taken in Durango by Baerg.

CENTRUROIDES VITTATUS (Say)

COMMON STRIPED SCORPION

This species (pl. 2, fig. 5) which is frequently referred to as *C. carolinianus* (Wood), has two broad, dark longitudinal bands on the dorsal side of the abdomen. In young specimens these bands are usually entire, but in most of the mature individuals they are partly or even entirely interrupted at the middle of each abdominal tergite. In adults of both sexes the appendages and the postabdomen are of a uniform yellowish brown except for the distal part of the sting, which is black. In young specimens the hands and the fifth segment of postabdomen are black, and the postabdomen has three longitudinal black stripes below. Male specimens have a very long postabdomen, but that of the female is only about a third longer than the abdomen. A male specimen measures 6.7 cm. in length, a female specimen, 5.9 cm.

C. vittatus probably occupies a greater area of the United States than any other scorpion. Pocock (1902) reports it from Georgia, Florida, Kansas, Texas, and California. The California record, however, should be ascribed to another species. Specimens in the National Museum are from Arkansas, Louisiana, New Mexico, and Texas. The species has also been reported from South Carolina and doubtless occurs in all the Gulf States as well as Kentucky, Tennessee, and Missouri.

Concerning the habits and life history of this species considerable is known. Out of doors it is found very abundantly under the loose bark of large trees and logs, and under logs and stones on the ground. About human habitations it prefers probably above all else the woodpile and crumbling stone or brick foundations. In some parts of Texas the writer has found it infesting back yards, and reports of its infestation of houses have been frequent. A number of specimens have been kept in captivity by the writer. One adult received October 2, 1925, was kept alive until late in August of 1926. In captivity *C. vittatus* feeds readily upon small roaches and flies, but refuses many kinds of insects and nearly all of the larger or hard ones. While other scorpions have been observed to dig into the ground in captivity, such a habit was not observed in this species. *C. vittatus* has a habit of clinging to objects lying on the ground, so that when the latter are turned over with the hands one is liable to press upon the scorpion and get stung.

The life history of *C. vittatus* has been studied by Smith (1927). He found the species to be ovoviviparous. Each young "was born in a very thin and transparent envelope from which it freed itself in about 15 minutes." The young molted in from 3 to 6 days

and remained on the back of the mother from 5 to 15 days. Smith estimates the period of growth at from three to four years.

The writer has induced this species to sting him and has observed the effects of its sting on others. At the time of the stinging there is a sharp pain, but this soon subsides. A small swollen area, or wheal, usually develops about the puncture point. This soon disappears. There are no permanent effects of the sting reported for the species as far as known to the writer.

CENTRUROIDES CALIFORNICUS (Girard)

CALIFORNIA CENTRUROIDES

The striped scorpion of California has been considered as a synonym of *C. vittatus* by Pocock (1902), but as pointed out by Wood it differs from *vittatus* in a number of ways. In the National Museum there are three specimens from California determined by Marx. Two of these are from Lake County and are labeled "*Centrurus vittatus* Say var. *californicus* W." and one is from Tule Lake and is labeled "*vittatus* Say" without any variety being given.

An examination of these specimens shows that the Lake County specimens are similar to *vittatus* but lack any definite dorsal stripes and have the integument much more roughened and in a manner noted by Wood. The one specimen from Tule Lake is without the subaculear tooth or practically so. It should be referred either to *C. exilicaudata* or a new species now to be described. All dorsal colorations are wanting in this specimen, but this condition may be due to the preservative used.

CENTRUROIDES SCULPTURATUS, new species

The writer has found an unstriped rough species (pl. 2, fig. 6) with a subaculear tooth in southern Arizona. It is related to *exilicaudata* but has the subaculear tooth. It is also related to *vittatus* and *californicus* but has neither spots or bands dorsally. It is described as follows:

General color a yellowish brown. There are no dorsal stripes, spots, or other color markings. Cephalothorax without dorsal color markings; median groove pronounced; integument granular. Hands slender, fingers about one and a half times as long as hand. On the posterior part of the carapace there is a pair of longitudinal, tuberculate, carinae that extend forward from the posterior margin about one-half the distance to the eyes. They are situated about one-third the distance from the median groove to the lateral margin of the carapace. Abdomen very coarsely granular above; each tergite with a more or less distinctly elevated tuberculate posterior margin and a well-developed median carina. Postabdomen longer than abdomen;

first segment about twice as long as broad; last segment with a long, slender, strongly curved sting, a low pointed tubercle below the sting and a swollen vesicle. About 24 teeth in pectinal comb. Length, 5.2 cm.

Type locality.—Tempe, Ariz.

Type.—Cat. No. 973, U.S.N.M.

Description based upon two adult specimens, a part of two lots as follows: One adult and one young from Tempe, Ariz., March 29, 1927, by the writer, under a stone in a rocky place, and one adult and one young from the same place, April 1, 1927, by the writer, under stones near a camp of Mexicans.

CENTRUROIDES OF NORTHERN MEXICO

In addition to the *Centruroides* species reported from the western United States in this paper, all of which probably occur in northern Mexico, there are others found there, which as far as known do not extend as far north as the United States boundary. These will be mentioned.

CENTRUROIDES SUFFUSUS Pocock

Judging from the material collected by Doctor Baerg in Mexico this is the common scorpion in the State of Durango. It is the Sonoran representative of *vittatus*, from which it differs in having the dorsal black stripes wider than the median yellow one and in having the interocular triangle but slightly, if at all, darker than the area behind the ocular tubercle, as well as in a few other particulars. It is near *exilicaudata*, but has bright stripes on the abdomen and a minute tubercle under the sting.

Pocock described *suffusus* as a subspecies of *vittatus*. This material came exclusively from the State of Durango, Mexico. Although compared with *Centruroides elegans* in the original description, the closest affinity of this form is probably with *C. ornatus* Pocock, of which it might with some propriety be considered a variety.

CENTRUROIDES ORNATUS Pocock

ORNATE SCORPION

Pocock described this species from Jalisco, Mexico. It is almost indistinguishable from his *suffusus*. In fact, the writer is somewhat inclined to consider the common striped scorpion of Durango, if it were to be recognized as only a subspecies, as a subspecies of *ornatus* rather than *vittatus* as was done by Pocock. Further collecting in Central Mexico will throw much light upon the true affinity of *ornatus*. One specimen in the Baerg collection from Atotonilco, Mexico, should be referred to this species.

CENTRUROIDES CHIARAVIGLI Borelli

Borelli (1915) described as new a species taken at Dinamita, State of Durango, Mexico. According to his description it is a pale yellowish species, with a triangular brown spot on the anterior part of the cephalothorax. The cephalothorax is densely and finely granular. The teeth in the pectinal comb of the male are 28 to 29; in that of female, 26 to 27. Length of male is given as 7 cm.; of female, 5.3 cm. Numerous examples of males, females, and young were obtained.

Borelli's description of this species is very suggestive of *C. suffusus* Pocock. That the males should exceed the females by 1.7 cm. in length is somewhat unusual. Pocock gives lengths of *suffusus* as follows: Male, 6.2 cm.; female, 4.6 cm. The ratio of Pocock's measurements are, however, similar to those of Borelli. I can find nothing in Baerg's collection of scorpions to correlate with this species except *suffusus*, which agrees in many respects.

Genus TITYUS Koch

In *Tityus* the first tarsal segment of leg IV is without distal spur. The fingers are provided with overlapping oblique rows of teeth but there are no supernumerary flanking rows.

This is an American genus. It is best represented in the Tropics but extends from California and Florida to Argentina. Only two United States species are known. They may be separated as follows:

KEY TO UNITED STATES SPECIES OF TITYUS

A[1]. Sting with large ventral tooth near base; total length about 8 cm. Found in Florida ---------- *T. floridanus* Banks.

A[2]. Sting without a ventral tooth; total length about 5 cm. Found in California ---------- *T. tenuimanus* Banks.

TITYUS TENUIMANUS Banks

CALIFORNIA TITYUS

Our knowledge of this species is limited to the original description of it which was published in 1910. It is described as a yellowish-brown scorpion, 2 inches in length, with a weakly keeled hand and long fingers. It differs markedly from the Florida species, in the absence of the tooth below the sting and in its much smaller size. The only record for it is from Buena Vista Lake, Calif.

Genus ISOMETRUS Hemprich and Ehrenberg

Isometrus is similar to *Tityus*, but the rows of teeth on the fingers of the chelae do not overlap. There are no supernumerary rows of flanking teeth.

The genus is represented in both the Old and New Worlds.

ISOMETRUS EUROPAEUS Linnaeus

This long known and widely distributed species is remarkable for the degree of sexual dimorphism shown. The female is of a rather slender body, but in the male the postabdomen and appendages are exceedingly slender. The postabdomen of the male is about twice as long as the body and the hand is about four times as long as broad. The general color is a reddish brown. The subaculear tooth is long, sharp, and conspicuous. The length of the male is from 6 to 7 cm. The species is frequently known under the name of *I. maculatus* De Geer.

This scorpion is reported from many parts of the world. It occurs in South America and the West Indies. In the United States it is known from Florida and California. There are two specimens in the National Museum, both from Key West, Fla.

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EXPLANATION OF PLATES

All photographs were taken by J. G. Pratt and are natural size.

PLATE 1

FIG. 1. *Hadrurus hirsutus* (Wood). Specimen from Calexico, Calif.
2. *Vaejovis boreus* (Girard). Specimen from Fort Pierre, S. Dak.

PLATE 2

FIG. 3. *Vaejovis yosemitensis*, new species.
4. *Vaejovis spinigerus* (Wood). Specimen from Papago Saguaro National Monument, Ariz.
5. *Centruroides vittatus* (Say). Male specimen from Texas.
6. *Centruroides sculpturatus*, new species. Specimen from Temple, Ariz.

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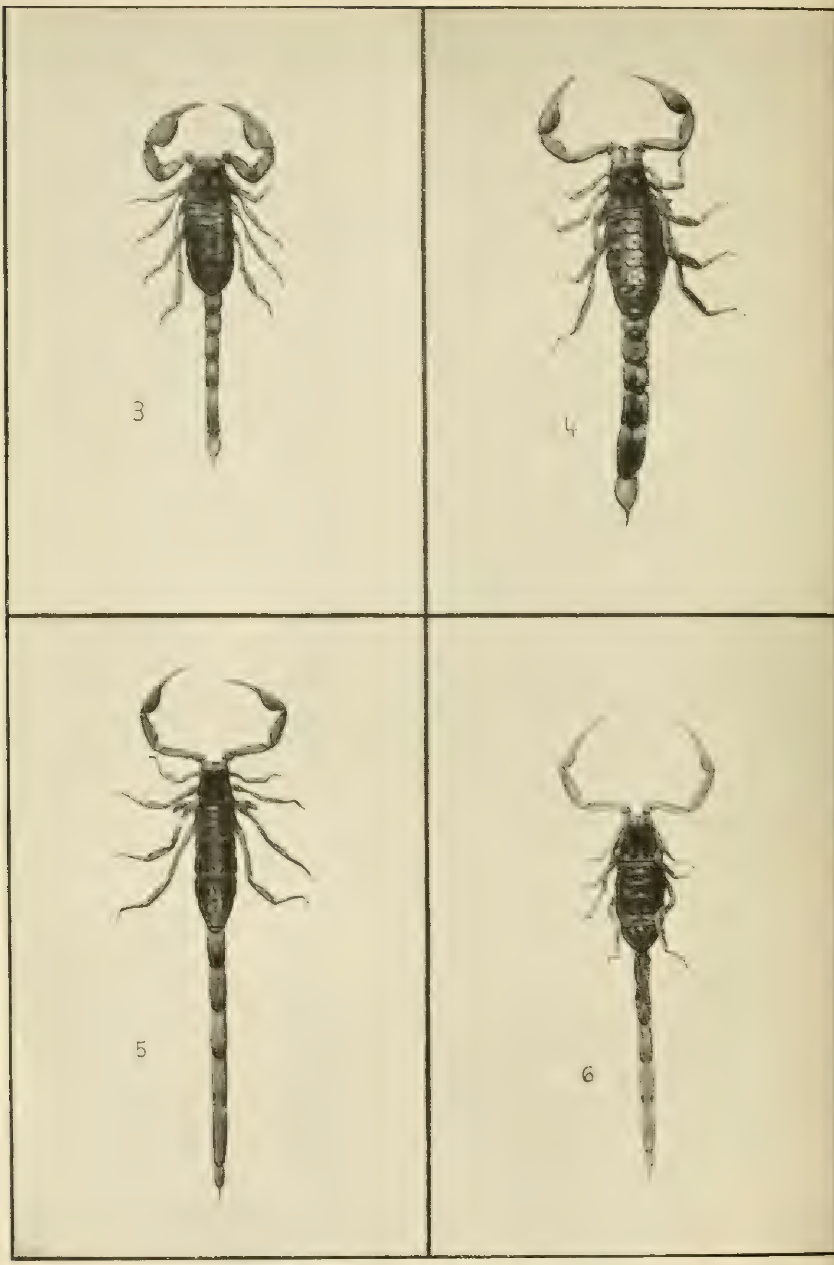
SCORPIONS OF WESTERN UNITED STATES

FOR DESCRIPTION OF PLATE SEE PAGE 24



SCORPIONS OF WESTERN UNITED STATES

FOR DESCRIPTION OF PLATE SEE PAGE 24

NEW VICKSBURG (OLIGOCENE) MOLLUSKS FROM MEXICO

By C. Wythe Cooke
Geologist, United States Geological Survey

The fossil mollusks described in the following pages were obtained in November, 1920, by Dr. T. Wayland Vaughan from the Alazan clay at and near the type locality on Rio Buena Vista, in Vera Cruz, Mexico. It was intended to include the descriptions, which were written in 1921, in a comprehensive account of the stratigraphy and paleontology of the area covered by Doctor Vaughan's investigations, but as some of the papers by other authors that were to have been included in that report are not yet written this contribution is published in advance of the others. Thanks are due to the officers of the Aguila Oil Co., who presented the collections to the United States National Museum and who have generously given permission to publish all the scientific results of Doctor Vaughan's expedition, and to the Director of the United States Geological Survey for permission to study this collection as part of the writer's official duties.

The illustrations are from photographs made by Mr. W. O. Hazard and retouched by Miss Frances Wieser.

The Alazan clay was originally described by Dumble [1] as follows:

Whether the fossiliferous shales at Alazan are an integral part of the lower hard blue shales or are unconformable upon them has not yet been fully determined, but they are probably later and are certainly upper Eocene.

The type locality of the Alazan shales is on the Buena Vista River at the crossing of the road between Alazan and Moyutlan.

At this place the stream has cut down to the blue shales and exposed that formation along its western bank and in the bed of the river for a distance of more than half a mile. Overlying the shales to the west is a hill of yellowish clay, probably Oligocene. On the east side of the river there is a broad valley covered to a depth of 20 feet or more with recent deposits.

The general body of the blue shale seems to have been but little disturbed; for the most part it is smooth and evenly bedded and has a low dip to the southeast. Three hundred yards below the crossing there is a limited area which shows the surface of the shale more or less disturbed and broken, and it is here that the fossils occur. In places it appears as if small basins or

[1] Dumble, E. T., Geology of the northern end of the Tampico Embayment area: California Acad. Sci., Proc., ser. 4, vol. 8, pp. 141–142, 1918.

potholes 8 to 10 feet in diameter had been eroded in the underlying shale and the fossil-bearing blue clays laid down in them. At other places the fossiliferous beds seem broken and piled together in every direction. The entire fossil-bearing area is not more than 200 feet in length, and a few hundred yards below this the main body of shales ends abruptly as though faulted, and the water plunges into a deep pool.

The material in which the fossils occur is very similar to that of the main body of the shales, but the fossils here are entirely confined to the disturbed and eroded area, and not a single fossil was found elsewhere in this exposure, and none at all was found in the main body of shale.

The fossils are fragile and, while abundant in this limited locality, are hard to separate from the shale.

The fossils from the Alazan shales were submitted to Dr. R. E. Dickerson, who reports that they are of upper Eocene age, containing some forms characteristic of the Tejon of California and others of the upper Eocene of the Gulf coast.

Although the Alazan clay has heretofore been correlated with upper Eocene deposits, study of the fossil mollusks has convinced the writer that the beds from which they came are of Vicksburg (Oligocene) age.[2] As the overlying Meson formation has been correlated with the Glendon formation, the Alazan doubtless is equivalent to the Mint Spring marl member of the Marianna limestone. No characteristic Eocene species were recognized. The species in the following list are common to the Alazan clay and the Vicksburg group of Mississippi:

Gemmula rotaedens (Conrad)
Pleuroliria cochlearis (Conrad)?
Pleurofusia aff. *P. servata* (Conrad)
Drillia tantula (Conrad)
Drillia cf. *D. caseyi* Aldrich
Latirus protractus (Conrad)?
Latirus perexilis (Conrad)
Distorsio crassidens Conrad
Phos mississippiensis (Conrad)
Turritella mississippiensis Conrad
Polynices (Euspira) byramensis Cooke
Sinum mississippiense Conrad
Architectonica trilirata vicksburgensis (Dall)
Cassis caelatura Conrad var.?
Pecten poulsoni Morton?
Macrocallista (Chionella) sobrina (Conrad)
Corbula laqueata Casey
Corbula engonata Conrad

The following species are described as new in this paper:

Gemmula alazana Cooke
Gemmula mexa Cooke
Gemmula mexa var. *mexita* Cooke
Pseudotoma alazana Cooke
Scobinella prionota Cooke
Glyptotoma rhombica Cooke
Borsonia aguilae Cooke
Ancilla (Ancillina) alazana Cooke
Protonema bartschi Cooke
Turritella ceibana Cooke
Natica alazana Cooke
Polynices (Lunatia) lacrimans Cooke
Polynices (Euspira) byramensis Cooke
Ampullina vaughani Cooke
Dentalium ovale Cooke
Dentalium alazanum Cooke
Amussium alazanum Cooke
Pecten ceibanus Cooke

The species named in the preceding lists probably include only a small part of the total number of mollusks in the Alazan clay. Al-

[2] This correlation was announced Dec. 27, 1923; see Geol. Soc. Amer. Bull., vol. 35, pp. 853, 856, 1924.

most as many more species are represented in the available collections by specimens which, although good enough to identify, are too imperfect to serve as types in view of the probability that more and better specimens will be found in the not distant future.

Characteristic specimens of *Anadara lesueuri* (Dall), a little ark that is very abundant in the Byram marl of Mississippi and rare in the Glendon formation, have been found in the Meson formation at Topila, Mexico.

The following descriptions of the localities at which the fossils were obtained are based upon memoranda furnished by Doctor Vaughan.

STATIONS M. 47 V., M. 48 V., M. 49 V., CROSSING OF THE ALAZAN-MOYUTLA ROAD

The exposures are a short distance south of (below) the road crossing over the river west of Alazan. The strata are much disturbed by minor crumpling. A thickness of 70 to 80 feet is exposed. Stations 48 and 49 represent actually or nearly the same bed, which is at the stratigraphically lowest part of the exposure. Station 47 is probably about 25 feet higher stratigraphically than station 48.

STATIONS M. 52 V., M. 53 V., M. 54 V., LA CEIBA CROSSING

This locality is on the east side of Rio Buena Vista, 9.8 kms. in a straight line above Tumbadero. A description of the exposure follows:

Section at La Ceiba crossing

	Feet
Quaternary:	
5. River silt, light grayish fawn colored	10
4. Coarse gravel and cobbles at base of river deposit	2 to 4
Unconformity.	
Oligocene: Alazan clay:	
3. Silty clay, originally light gray, weathers to medium fawn colored; collection M. 52 V	4
2. Fine to medium grained, light lead to dark fawn colored, soft sandstone; grains not well rounded; collection M. 53 V	0 to 1
1. Light lead colored clay; collection M. 54 V	1

On the slope along the eastern side of Rio Buena Vista 50 feet above the base of the exposure described above and separated from it by fluvial deposits there is an outcrop of a yellowish foraminiferal limestone composed largely of *Lepidocyclina undosa* var. *tumida* Vaughan, a Meson species of *Operculina*, and other larger Foraminifera. As there is no indication of local faulting, it appears that the foraminiferal limestone occurs stratigraphically about 45 feet higher than bed No. 3 of the exposure on the river. Whether an unconformity or disconformity intervenes between the top of the Alazan and the base of the Meson can not be determined from these

exposures, but exposures elsewhere suggest stratigraphic gradation without the intervention of an erosion interval. As the Meson is at least approximately the equivalent of the Glendon formation of the eastern Gulf States, the stratigraphy indicates that the typical Alazan corresponds to a part of the Oligocene older than the Glendon.

DESCRIPTION OF SPECIES

GEMMULA ALAZANA, new species

Plate 1, Figure 1

Shell polished, apical angle about 28°; nucleus of four or five convex whorls, the first two apparently smooth, others with close-set axial costae; later whorls carinated, carina very slightly anterior to the middle, crenulated; posterior slope concave, with one spiral thread close to the suture and several very faint threads; anterior slope slightly concave, steeper, with several threads of variable fineness and one coarser thread adjacent to the suture; anterior end of body whorl with two coarse threads and many finer threads; aperture about one-third the length of the shell; canal straight; anal sinus at the carina; inner lip enameled. Length of specimen with six and one-half postnuclear whorls, 15 mm.; breadth, 6.1 mm.

Gemmula alazana closely resembles *G. mexa*, but is more slender, lacks the double threads on the carina, and has a shorter nucleus.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista, west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352695, U.S.N.M.

GEMMULA MEXA, new species

Plate 1, Figures 2, 3

Shell polished, apical angle about 35°; nucleus of five and one-half or six convex whorls, the first two very small, smooth, others decorated with close-set axial costae; later whorls carinated; carina slightly anterior to the middle, crenulated, with two adjacent nodular threads, the posterior threads somewhat more strongly nodular than the other; posterior slope concave, with a faint thread near the suture; anterior slope concave; anal sinus deeply reentrant at the carina. Body whorl broken in type; in very young shells the canal is short and straight, and the anterior end of the body whorl is set with spiral threads. Length of nucleus and five and one-fourth subsequent whorls, measured to carina, 8.6 mm.; maximum diameter, 6 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan. (M. 49 V.)

Type.—Cat. No. 352693, U.S.N.M.

GEMMULA MEXA var. MEXITA, new variety

Plate 1, Figure 4

Variety *mexita* differs from typical *G. mexa* in having three threads on the anal fasciole and several faint threads on the posterior slope.

Occurrence.—With the preceding. (M. 49 V.)

Type.—Cat. No. 352694 U.S.N.M.

PSEUDOTOMA ALAZANA, new species

Plate 1, Figure 5

Shell obese, apical angle about 62°; nucleus smooth, of two and one-half convex whorls; subsequent whorls medially carinated, loosely appressed, ornamented with close low corrugations marking growth stages and many fine revolving threads; posterior slope concave; anterior slope nearly straight to the suture; base of body whorl concave to the sutural band; anal sinus shallow, situated between the suture and the carina. Length of nucleus and three and one-half postnuclear whorls, measured to the carina, 9 mm.; breadth, 9 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista, west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352697, U.S.N.M.

SCOBINELLA PRIONOTA, new species

Plate 1, Figures 6, 6*a*

Shell polished, slender, apical angle about 35°, whorls appressed, peripheral outline serrate; tip of nucleus obtuse, with about three and one-half convex whorls, smooth except last one-fourth whorl, which is axially ribbed; subsequent whorls, 7 in type, coronated; posterior half of whorl concave to a strong antesutural thread; middle of concavity occupied by a nodular thread which marks the deepest reentrant of the anal sinus; coronal band divided by a groove which on the earlier whorls is medial but on the later whorls is anterior to the nodes on the corona; nodes of corona blunt, serrate, twelve on the seventh whorl; suture bordered by nodular threads, the anterior being stronger than the posterior; base of body whorl cancellated, axial outline serrate; aperture rather narrow, less than half the length of the shell; canal straight; outer lip broken, inner lip with two principal columellar folds and three or four faint secondary folds. Length (anterior tip broken), 15.5 mm.; breadth, 6 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista, west of Alazan, Mexico. (M. 48 V.)

Type.—Cat. No. 352696, U.S.N.M.

GLYPTOTOMA RHOMBICA, new species

Plate 1, Figures 7, 7*a*

Shell small, outline rhombic, stout, apical angle about 57°; nucleus blunt, with two convex polished whorls, smooth except the last one-fourth whorl or less, which has three faint axial riblets; four subsequent whorls with a broad antesutural band having two strong spiral threads, next, an equally broad, slightly concave band with one fine thread, next, a peripheral band of the same width with two strong threads; base of body whorl set with alternating coarse and fine threads; entire surface except nucleus and anterior tip cancellated by close threads parallel to the growth lines; anal sinus deeper than broad, coinciding with the peripheral band; aperture broad, a little more than half as long as the shell; outer lip internally lirate, inner lip with two very high columellar folds; canal straight, flaring at the tip. Length, 6 mm.; breadth, 3.2 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352698, U.S.N.M.

BORSONIA AGUILAE, new species

Plate 1, Figures 8, 8*a*

Apical angle about 35°; nucleus of two or three whorls, apparently smooth; posterior half of postnuclear whorls concave to a rounded antesutural collar which becomes obsolete on mature whorls, smooth except for faint spiral lines and growth lines; anterior half of whorls with distinct spiral threads continuing to tip of body whorl, but only four visible on whorls of spire; periphery angular; cut by short round costae about as high as wide, nine costae on sixth whorl; canal straight; aperture nearly half as long as the shell; outer lip broken, inner lip carrying one strong columellar fold with a much weaker fold in front of it; anal sinus semilunate, deepest part midway between the periphery and the suture. Length, 12.5 mm.; breadth, 5 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 48 V. and M. 49 V.)

Type.—Cat. No. 352699 U.S.N.M.

ANCILLA (ANCILLINA) ALAZANA, new species

Plate 1, Figures 9, 9*a*

Shell small, subulate; nucleus conical, of about three convex whorls, scarcely separable from the subsequent whorls; postnuclear whorls barrel-shaped; suture bordered posteriorly and nearly concealed by a band of enamel which extends backward from the aperture and gives the earlier whorls a medially constricted appearance; aperture

narrow; canal short; basal notch shallow; basal fasciole narrow, marked by two grooves. Length, 7 mm.; breadth, 2.8 mm.

Some specimens of this species preserve traces of the original color. The shell appears to have been light brown with a darker line at the suture and a nearly white band of enamel behind the suture.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. Abundant. (M. 48 and M. 49 V.)

Type.—Cat. No. 352700, U.S.N.M.

PROTONEMA, new genus

Melanellids having the nuclear whorls spirally threaded.

Genotype.—*Protonema bartschi*, new species.

PROTONEMA BARTSCHI, new species

Plate 1, Figures 10, 10*a*

Shell robust, apical angle about 28°; suture impressed; nucleus of about four whorls, dextral, first whorl very minute, others convex, with three spiral threads; later whorls polished and smooth except for faint axial growth lines; first and second postnuclear whorls globular, later whorls flattened; fifth and subsequent whorls constricted in front of the suture, giving rise to an antesutural collar; parietal wall free from callus; outer lip broken in all the specimens at hand. Length, 5 mm.; diameter, 2 mm. Another specimen attained a length of 7 mm. and a diameter of 3 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista at La Ceiba Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352701, U.S.N.M.

TURRITELLA CEIBANA, new species

Plate 1, Figures 11, 12

Shell long, slender, apical angle 12° to 14°; suture deeply impressed; whorls decorated with two pairs of raised beaded threads adjacent to the suture and one lower beaded thread in the depressed medial region. Length of a broken specimen of nine whorls, 33.5 mm.; diameter at larger end, 8.75 mm.; diameter at smaller end, 3 mm.

This species somewhat resembles *T. praecellens* Brown and Pilsbry, but lacks the fine riblets and differs in other details of sculpture.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista at La Ceiba road crossing, Vera Cruz, Mexico (M. 53 V.); Antigua, B. W. I., Cat. No. 167006 U. S. National Museum.

Type.—Cat. No. 352702, U.S.N.M.

NATICA ALAZANA, new species

Plate 2, Figures 1, 1*a*, 1*b*

Shell small, thick; whorls four and one-half, smooth except for deep grooves that extend forward from the suture almost to the periphery; suture well marked; aperture asymmetrically semilunate, wider in front than behind; inner lip contiguous to the whorl for half its length; umbilicus with one strong rib. Length, 6 mm.; breadth, 5 mm.

Natica alazana closely resembles *Natica* "*canrena*" from the Chipola formation of Florida, but its whorls are more convex than those of the Florida species.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352704, U.S.N.M.

POLYNICES (LUNATIA) LACRIMANS, new species

Plate 2, Figures 2, 2*a*, 2*b*

Shell small, globular, spire moderately high; whorls rounded, smooth except for antesutural corrugations which become obsolete on the body whorl; aperture large, semilunate; callus half filling the umbilicus, set with a medial bump resembling a teardrop and separated from the rest of the callus by shallow depressions. Length, 8.5 mm.; breadth, 7.2 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. Abundant. (M. 47, 48, 49 V.)

Type.—Cat. No. 352705, U.S.N.M.

POLYNICES (EUSPIRA) BYRAMENSIS, new species

Plate 2, Figures 3, 3*a*, 3*b*

Lunatia sp. g., Cooke, U. S. Geological Survey Prof. Paper 129, p. 84, 1922.

Spire rather low, sides flattened; whorls, five, constricted in front of the suture; body whorl large; aperture semilunate; umbilicus large, with a broad, low, rounded, spirally striated rib continuous with the callus of the inner lip and bordered anteriorly by a shallow sulcus; callus of inner lip thin. Length, 13.4 mm.; breadth, 12.7 mm.

The umbilical rib is very inconspicuous in all the specimens examined except the type.

This species is rather rare at Vicksburg and Byram, Miss. The specimens from Mexico are small and broken, but seem to have no specific differences from the Mississippi forms.

Occurrence.—Oligocene, Byram marl, Vicksburg, Miss. (type, station 3722) and Byram, Miss. (station 6454); Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352706, U.S.N.M.

AMPULLINA VAUGHANI, new species

Plate 2, Figures 4, 4*a*, 4*b*

Shell small, globose, of about four whorls, spire low; aperture elliptical, posterior half of inner lip thickened and callous; basal fasciole raised, smooth, curved, sharply set off from the remainder of the body whorl and from the umbilicus; umbilicus large, open anteriorly, partly covered posteriorly by the callous inner lip. Length, 5.2 mm.; breadth, 5 mm.

This species is described from a unique specimen which may be young but which appears to show the characteristics of mature shells.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352707, U.S.N.M.

DENTALIUM OVALE, new species

Plate 2, Figure 5

Shell large, covered with many close-set subequal ribs, those on the concave side a little finer than the others; transverse outline elliptical, the shorter axis in the plane of curvature of the shell; shell thick, concave side thicker than the convex. Length of fragment, 18 mm.; maximum diameter at larger end, 5.5 mm.; minimum diameter, 4.8 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 49 V.)

Type.—Cat. No. 352708, U.S.N.M.

DENTALIUM (DENTALIUM) ALAZANUM, new species

Plate 2, Figures 6, 6*a*

Shell moderately large, curvature slight; sculpture, near the tip, of 16 longitudinal ribs, increasing in number toward the aperture by intercalation, all attaining nearly equal size; entire surface covered with elevated transverse riblets, unequally spaced and of unequal size.

This species is known only from fragments, the largest being 16 mm. long and 3.5 mm. in diameter. Of living eastern American species, *Dentalium alazanum* most closely resembles *D. carduus* Dall, but its sculpture is much coarser and more irregular. I know of nc comparable fossil species.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan, Mexico. (M. 48, 49 V.)

Type.—Cat. No. 352709 U.S.N.M.

AMUSSIUM ALAZANUM, new species

Plate 2, Figures 7, 7*a*

Shell small, thin, suborbicular, nearly equilateral, somewhat tumid medially but compressed laterally, surface smooth except for very faint growth lines and *Camptonectes* striations; apical angle about 115°; ears large, subequal; internal sculpture of ten strong, round, threadlike ribs extending from the umbo, where they are covered by a thin layer of shell, nearly to the margin and ending in flattened nodes. Height, 7.8 mm.; width, 7.6 mm.

The length and number of internal ribs are variable. Another specimen nearly the same size as the type has 11 ribs, and the ribs extend only about two-thirds the distance to the margin. The distal third is smooth and very thin.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista west of Alazan (M. 49 V.) (type) and at La Ceiba Crossing, 9.8 kms. above Tumbadero (M. 52 V., M. 54 V.).

Type.—Cat. No. 352710, U.S.N.M.

PECTEN CEIBANUS, new species

Plate 2, Figure 8

Right valve equilateral, moderately inflated; ribs 21, round but slightly grooved distally; interspaces nearly flat, narrower than ribs; submargins narrow, convex; anterior ear with about 3 riblets, broken distally; byssal notch apparently shallow; posterior ear oblique, with about 6 riblets; finer sculpture nearly obliterated in type but traces of close-set scabrous sculpture which probably originally covered entire shell remain near distal margin.

Height, 28 mm.; width, 32 mm.; diameter of right valve, 8 mm.

Occurrence.—Oligocene, Alazan clay, Rio Buena Vista at La Ceiba Crossing, 9.8 kms. above Tumbadero, Vera Cruz, Mexico. (M. 53 V.)

Type.—Cat. No. 352711, U.S.N.M.

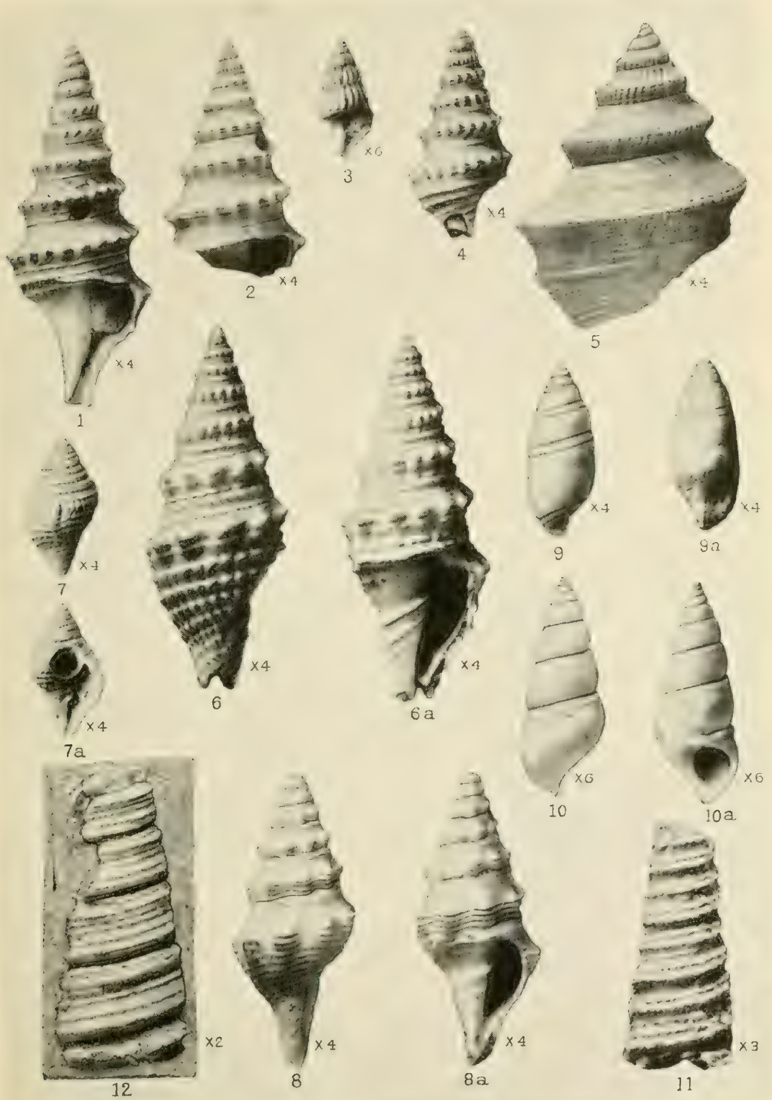
EXPLANATION OF PLATES

PLATE 1

FIG. 1. *Gemmula alazana* Cooke
2. *Gemmula mexa* Cooke
3. *Gemmula mexa* Cooke (apex)
4. *Gemmula mexa* var. *mexita* Cooke
5. *Pseudotoma alazana* Cooke
6. *Scobinella prionota* Cooke
7. *Glyptotoma rhombica* Cooke
8. *Borsonia aguilae* Cooke
9. *Ancilla (Ancillina) alazana* Cooke
10. *Protonema bartschi* Cooke
11. *Turritella ceibana* Cooke
12. *Turritella ceibana* Cooke

PLATE 2

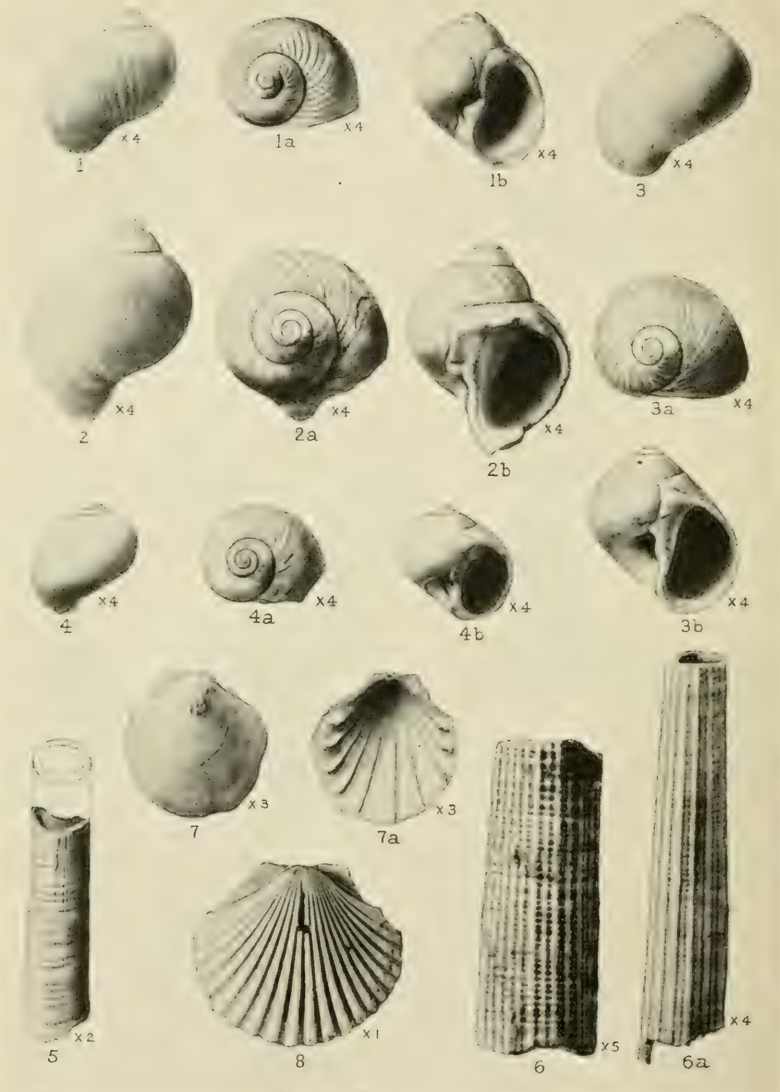
FIG. 1. *Natica alazana* Cooke
2. *Polynices (Lunatia) lacrimans* Cooke
3. *Polynices (Euspira) byramensis* Cooke
4. *Ampullina vaughani* Cooke
5. *Dentalium ovale* Cooke
6. *Dentalium (Dentalium) alazanum* Cooke
7. *Amussium alazanum* Cooke
8. *Pecten ceibanus* Cooke



VICKSBURG MOLLUSKS FROM MEXICO

Plates have been reduced about 16 per cent

FOR EXPLANATION OF PLATE SEE PAGE 10



VICKSBURG MOLLUSKS FROM MEXICO

Plates have been reduced about 16 per cent

FOR EXPLANATION OF PLATE SEE PAGE 11

A PREHISTORIC PIT HOUSE VILLAGE SITE ON THE COLUMBIA RIVER AT WAHLUKE, GRANT COUNTY, WASH.

By Herbert W. Krieger
Curator of Ethnology, United States National Museum

During the spring and early summer months of 1926 and 1927 a regional archeological survey of the middle and upper Columbia River Valley was made by the writer for the Bureau of American Ethnology. This survey is part of a larger project to determine how far the general plateau culture may be classified according to its subareas and to what extent these subareas interrelate with each other and with early cultures on the north, west, east, and south. The survey began with a study of the extensive collections obtained by members of the Columbia River Archeological Society from burials and surface finds at various ancient and historic Indian village sites and cemeteries in the middle and upper Columbia River Valley.

Most noteworthy among the collections studied are those of H. T. Harding, of Walla Walla; the Eells collection of Whitman College, also of Walla Walla, Wash.; of Adams H. East, O. B. Browne, R. T. Congdon, T. H. Grosvenor, of Wenatchee, Wash.; of F. C. Evertsbusch and others of Pateros, Okanogan County, Wash.; of Earl Simmons and others, of Quincy, Wash.; and the extensive and valuable material collected by F. S. Hall and others for the State Museum of Washington in Seattle. Enthusiastic interest in the survey was shown by members of the Columbia River Archeological Society who have done pioneer work in locating many aboriginal villages and burial sites and in gathering and classifying many different types of archeological material.

Information as to location of sites and distribution of type specimens was in every instance cheerfully given. A check was made on data already collected, amplified in several instances by a visit to the reported location of an isolated pit-house ruin, camp site, or talus burial.

The next step in the survey was the plotting of an archeological map of the middle and upper Columbia and tributary river valleys showing known aboriginal village sites and cemeteries. The necessity for obtaining an archeological map of the valley at this time becomes

apparent when one notes that the ancient Indian village site is usually the most favored location chosen by the modern orchardist for his planting. The reason for this lies in the need of each for protection, shelter, and an adequate water supply. A young orchard can successfully be developed only on a level river bench high enough to be secure against seasonal flood waters and near enough to the towering escarpment of the river bluffs for shelter from the winds which sweep over the plateau above. It was just this type of narrow bench land, located above danger from floods and close to the precipitous basaltic or lava-capped river bluff, that was selected by the prehistoric occupant of the Columbia River Valley as a location for his permanent winter home. Here, under the practically inaccessible cliff barrier, was security for the primitive group against attack by hostile bands.

As the middle and upper Columbia River Valley is semiarid and barren to a degree, an adequate water supply is essential. The bench land selected as a village must be neither too high nor the banks too steep to preclude easy access to the river. On the sloping beach below the river bench were obtained useful varieties of stone pebbles, float bowlders, and driftwood.

From The Dalles, in Oregon, and Spedis, located on the Washington side of the Columbia, to the environs of Kettle Falls, near the Canadian border, the mapping of archeological stations was continued both along the middle and upper Columbia and tributary river valleys as the lower Snake, Yakima, Walla Walla, Deschutes, John Day, Wenatchee, Methow, Okanogan, and others.

Exploration and study previous to this survey of the prehistoric culture types of the middle and upper Columbia River Valley have been limited in extent or have been supplementary to a project covering another field. Though limited in their scope, these studies have produced conclusive archeological data.

In volume 1, part 2, of the Memoirs of the American Anthropological Association, published in 1906, there appears a monograph by Albert B. Lewis on the "Tribes of the Columbia Valley and the Coast of Washington and Oregon." This is an excellent summary of source material concerning the Indian tribes of the Pacific Northwest coast and those of the Columbia and tributary river valleys in so far as early historical contacts, travel, and exploration accounts are concerned. Conclusions drawn by Lewis with regard to aboriginal culture areas and subareas, tribal migrations, and trade relationships as they existed at the time contact was first established with the white race through exploring expeditions such as that of Lewis and Clark are still applicable and are for the most part sound.

"The stone arrowheads, stone mortars and pestles, and carved stone images and animal heads found along the Columbia from the mouth

of the Willamette to near the mouth of the Snake show that the similarities throughout this region are not of recent origin. Some of the finest and best carvings come from above The Dalles, while very few, if any, have been found below the mouth of the Willamette. It would hence appear that this stonework, if it did not originate, at least had its highest development in a region where wood was scarce, and thence probably moved down the river. On the lower river wood carving probably took its place, as the wood here was soft and easily worked with stone and shell tools."

In commenting on the archeology of the interior tribes of the Columbia Valley, Lewis refers to the need for further knowledge regarding culture centers and the various sources of culture diffusion that must have influenced the large area known as the upper plateau and the Great Basin.

A study of a limited area of the upper plateau region at Lytton and other sites on the Thompson River in southern British Columbia with regard to its archeology and early culture connections was made by Harlan I. Smith. A summary of his investigations was published in the Bulletin of the American Geographical Society.[1]

Smith also carried on archeological investigations for the American Museum of Natural History during 1903 in the Yakima Valley in Washington between Clealum of the forested eastern slope of the Cascade Mountains and Kennewick on the Columbia River; also between the mouths of the Yakima and Snake Rivers in the treeless arid region of the Columbia Valley and in the vicinity of Priest Rapids. Smith concludes that definite age can not be assigned to archeological finds made during his investigations, but that they antedate the coming of the white man to the valley of the Columbia, as no objects of European manufacture were included.[2]

Smith finds that the partial identity of the Yakima Valley and Thompson River region in the southern interior of British Columbia is supported by definite evidence. "The preponderance of chipped points over those ground out of stone; cache pits; circular lodges; rings of stones; and of semisubterranean houses with stones on the encircling ridge; pairs of arrow-shaft smoothers, and bone tubes, were all found to be common to both regions. Tubular pipes, modern copper tubes or beads, incised designs consisting of a circle with a dot in it and engraved dentalium shells, each of a particular kind, besides pictographs in red, rock-slide sepulchres, modern graves walled up with parts of canoes, the marking of recent graves with sticks, and the custom of burying artifacts with the dead were also

[1] Vol. 38, May, 1906.

[2] His larger publication on the "Archeology of the Yakima Valley" appeared as vol. 6, pt. 1, of the Anthropological Papers of the American Museum of Natural History published in 1910. The results of his studies in British Columbia were published in 1900 as a part of the publications of the Jesup North Pacific Expedition.

found to be common to both areas. Circles of stones which mark places where cremated human remains were found in this region sometimes indicate graves in the Thompson River region."

During the months of August and September, 1924, an archeological reconnaissance of the lower Columbia River region was conducted for the University of California department of anthropology by W. D. Strong, W. Egbert Schenck, and H. J. Biddle. One of the features of this reconnaissance was a study of petroglyphs on the Washington or northern side of the Columbia River across from The Dalles, Oreg. Some of the findings of this study were published in the American Anthropologist.[3] The authors correlate technique and designs shown in the rock paintings and sculptures, especially those of realistically conceived and executed animal figures among which the buffalo, mountain sheep, elk, and deer, with those described by Spinden from Idaho and by Mallery from Utah, also with recently described petroglyphs from Virginia City, Nev. The authors conclude "that while the data are scattered and incomplete The Dalles petroglyphs in question find their closest analogues in the Great Basin area, and would appear to mark the northwesterly limit of that type. * * * The validity of the tentative conclusions arrived at in this paper can only be substantiated by a more thorough study of the petroglyphic and pictographic art of the upper Columbia River and adjacent areas."

An area contiguous to that of the Middle Columbia River Valley on the east was investigated archeologically and ethnologically by Herbert J. Spinden in the summer of 1907 for the Peabody Museum. The results of this and later studies were incorporated in a monograph appearing in the Memoirs of the American Anthropological Association and entitled "The Nez Percé Indians."[4] The area occupied by the Nez Percés within historic times extended from the Bitterroot Mountains on the east to the Blue Mountains on the west, so that the territory claimed by them included what is now a large part of central Idaho, eastern Washington, and eastern Oregon, located within the basin of the Snake River.

The Nez Percés are of the same linguistic stock as the Shahaptian tribes of the Columbia Valley. Their material culture possesses many traits in common, although environmental differences, due in part to the presence of the bison, and a closer proximity to the Indian tribes of the Plains and remoteness from the tribes of British Columbia have caused a cultural development along somewhat different lines than that possessed by the ancient sedentary tribes of the middle Columbia before the coming of the horse. Other cultural differences may be noted in the type of house structures; art designs

[3] Vol. 27, No. 1, January, 1925. [4] Vol. 2, pt. 3, 1908.

incorporated on surfaces of horn, wood, bone, and stone; substitution of the bowl for the tubular stone pipe, and the entire absence of jade celts and of ornamental objects of copper was noted in some of the ancient cemeteries excavated by the writer along the lower and middle portions of the Snake River Valley. Ancient basketry designs also varied in the two areas.

Investigations at the better known early centers of Indian population at The Dalles by the department of anthropology of the University of California have led to the discovery of objects and of art designs similar to those of the wooded area of the lower Columbia Basin, although many surface finds of a varied nature have been made there. All of the upper plateau tribes had recourse to the salmon and other varieties of fish in the Columbia and tributary streams and derived in this manner a plentiful food supply. Groups from each of the plateau tribes visited well-known fishing grounds at the several rapids and falls. It is therefore possible to make minor comparisons of the various kinds of abandoned fishing equipment, pestles, bowls, kitchen middens, and other implements and domestic equipment left by these groups at the place of their temporary encampment. Due to the temporary nature of hunting and fishing camps, the large subsurface deposits of charcoal, kitchen refuse, arrow points, canoe parts, and other fragmentary objects found in the vicinity of these great trading and fishing centers afford no reliable indication of age. The impermanent and unstratified character of the soil in the shifting beach or low river bench in which such deposits are found is less likely to yield important archeological results than are the permanent winter village sites, with their ruins of abandoned pit houses and adjacent cemeteries.

The falls and gorge of the Columbia River where this stream breaks through the Cascade Mountains marks the beginning of the wooded area of the lower river valley. The early aboriginal inhabitants of this region possessed a distinct type of culture which was based principally on the use of wood in their arts and crafts, while the tribes occupying the middle and upper river were expert in the utilization of stone, horn, and bone. Realistic carvings of human figurines in wood and bone, and curvilinear surface etchings on wood, bone, and stone characterize the lower valley, while a more formal, conventional rectilinear design executed chiefly on antler and stone distinguish the art of the arid middle Columbia Valley.

Traces of Indian occupation are in process of rapid obliteration by the plow which is to-day the most productive excavator of antiquities. Of the many sites inspected by the writer, excavation was undertaken at eight. The largest collection of material exhumed, such as ceremonial burial offerings and skeletal remains, was obtained from the prehistoric pit house village site and cemetery at Wahluke, Grant County,

Wash. There was no evidence that burials there had ever been disturbed. Neither was there in the objects recovered from the graves any indication of Hudson's Bay Co. influence such as trade beads of glass or of shell beads which in historic times were traded to the Indians as a substitute for the *Dentalium indianorum*, or of iron knives or copper implements. It was likewise impossible to obtain at Wahluke any direct evidence of great antiquity of occupancy or of culture type.

Wahluke is in Grant County on the west bank of the Columbia River, which in this part of its course flows north, immediately south of the point where the stream impinges on the precipitous escarpment formed of yellowish gray volcanic débris, white silt, volcanic dust, and ash known as White Bluffs. Wahluke is the site of a former pit-house village consisting of 30 semisubterranean structures erected in an irregular row extending a distance of 100 rods along the river bench. Each habitation ruin to-day consists of nothing more than a stone-capped rim of earth surrounding a centrally excavated pit of varying depth with a diameter of 30 or more feet. The bench land at Wahluke is broad and high enough to afford protection against the flood waters of the Columbia. The opposite flank of the river is much lower and is subject to seasonal inundations, hence was not occupied by the ancient inhabitants of the region except as a place for procuring game. Low-lying river benches gradually sloping down to the river's edge were favored watering places for animals which often traveled many miles to reach them, although no evidence was uncovered that the bison ever reached this region.

The high river bluff which faces Wahluke at right angles on the north is an exposed section of the Ellensburg formation laid down in the late Tertiary in old fresh water lake beds that at one time extended from the Pacific coast to what is now the upper plateau country east of the Cascade Mountains. In the valley of the Yakima River the composition of the Ellensburg formation is coarser than that of the White Bluffs on the Columbia River which contains large quantities of volcanic ash and wind-blown dust.

At Wahluke the Columbia River is deflected in a general southeasterly direction, where it completes the final sector of its course known as the big bend. The vertical escarpment of the White Bluffs formation lies hard against the northern end of the village site; the cemetery proper is an extension of the village and is directly south of the long and irregular row of semisubterranean pit-house ruins. White Bluffs extend in a line reaching from east to west. From the point where the channel of the Columbia is deflected, the escarpment continues on the west as a range of hills known as Saddle Mountains or, locally, as Sentinel Bluffs, forming a relief feature several hundred feet high. Twenty-five miles farther west this range

again lies at right angles to the Columbia, where the channel cuts a gap through it. This gap is just below the confluence of Crab Creek, and about 40 miles by a circuitous course upstream from Wahluke. From the gap through Saddle Mountains to Wahluke the river inscribes a semicircle to which Saddle Mountains and White Bluffs are tangent. During this section of its course, the Columbia River passes over the 15-mile stretch of Priest Rapids, famous as a gathering place for various tribes during the fishing season. Here, on the west bank, was located the village of Smohalla, a leader in the Ghost Dance cult.

Saddle Mountains are of importance ethnologically, as the range forms one of the few natural geographic barriers. Within historic times this range separated the Shahaptian-speaking tribes on the south such as the Wanapûm, or Columbia River Indians, the Palüs, the Yakima, the Walla Walla, the Umatilla, and other tribes from the Salish groups, as the Kalispel, Winatshi, Okanagan, Nespilim, and others that occupied the region of central and eastern Washington north of the range.

Saddle Mountains are geologically important because of their bearing on any attempted interpretation of the antiquity of man in the valley of the Columbia. In the deeply cut gorge of this river, in its escarpment of columnar basalt, is written much of the early Tertiary geologic history of central Washington. South of Saddle Mountains the basaltic lava flow is covered with thick deposits of andesitic materials, volcanic ash and dust, and loess.

During the Miocene, sheet after sheet of basaltic lava was poured out over the greater part of Washington, all of eastern Oregon, part of California, and a large area in the Snake River Valley of Idaho. This basalt represents a great number of flows. About 20 of these are exposed in some of the lava bluffs of the Columbia and Snake Rivers. A cross section of the gorge cut by these rivers shows intervening beds of varying thickness of soil in which trees grew to a thickness of several inches before they were charred and buried by later flows. Embedded sand, clay, gravel, and soil débris all bear evidence of burning and baking.

After the completion of the period of basaltic upheaval and the later depositions of andesitic material in the fresh water lake beds which characterized the Tertiary history of central Washington, there began the gradual uplift of the Cascades in the Pleistocene and the formation of the high plateau region. The invasions of ice sheets from the north and from the northeast date from this period. One of these great ice sheets came down the valley of the Okanogan River from the north and filled the old channel of the Columbia River, causing it to form new and more direct ones, among the more important of which are the Moses and Grand Coulees. Later, on the

recedence of the ice sheet, the Columbia River again followed its old channel, which it still occupies.

Any cursory study of the geological history of the Columbia Valley must indicate that human occupation of this region during the Pleistocene was impossible. Supposedly valid evidence of man's antiquity in the valley of the Columbia has been found, nevertheless, in the form of crude, unfinished stone implements cached in the vicinity of a glacial morraine in the Lake Chelan country. This cache, however, is entirely superficial or intrusive and was deposited at a much later date.

Another cache of unfinished knives or spear points, shaped likewise from andesite porphyry, was found embedded in a cremation burial on a bench of the Columbia River at a location locally known as Simmons' graveyard, near Quincy, Grant County, Wash. The burial here is unique in that it lies directly underneath and several feet below a pit-house village erected at a later date. The crude appearance of the roughly chipped unfinished leaf-shape thick sectioned stone blades has led to the mistaken assumption of great antiquity.

Pleistocene faunal remains which protrude from the vertical escarpment of the White Bluffs formation along the Columbia River near Wahluke and are associated with weapon points and implements of chipped stone are no true indication of a living association of Pleistocene fauna and ancient man, as has been supposed. The elevation above the country surrounding White Bluffs provided a splendid observation point for the Indian bunter in search for game or on the the lookout for hostile strangers. White Bluffs also was a well-marked trail used by the Indian when he journeyed eastward and northward away from the river on food-gathering expeditions. The chipped stone objects found are clearly intrusive and belong to a much later date. The geologic history of central Washington does offer, however, an explanation in part of the material culture of the early occupants of Wahluke. Environmental factors there have served as a causative agent, likewise as a barrier to the development of a culture complex within other than certain conscribed limits. This basic fact is most strikingly brought out in a consideration of their stone culture.

Evidence obtained from the nature of the objects exhumed at Wahluke would appear to indicate that in prehistoric times up to some as yet undetermined date there existed a close connection of material culture and tribal practices throughout the entire area of the western plateau in what within historic times became known as distinctly Salish, Shahaptian, and Shoshonean cultures. There is definite evidence that this culture extended far to the south and formed the nucleus or substratum of the Basketmaker culture of the Southwest.

At many places along the banks of the Columbia and tributary streams sedimentary deposits are exposed which were carried down in

the flood waters caused by the melting of the snow in the Cascades and in the Rocky Mountains. These deposits often cover charred cooking stones, heaps of charcoal, kitchen refuse, and occasionally artifacts shaped from stone, horn, and bone, together with other definite evidence of the location of a camp or burial ground. Temporary fishing camps, where many discarded objects of domestic use and weapons and implements of stone and bone were abandoned and covered with several thick deposits of sediment, were again in later years exposed when the stream formed a new bed or when flood waters eroded the banks. At Pateros, in Okanogan County at the confluence of the Methow River with the Columbia, seven strata showing human occupancy with intervening layers of sedimentary deposits are exposed on the flanks of a small island formed on the Methow side of the channel. At Vantage Ferry, Kittitas County, on the west bank of the Columbia River there are three such strata, and so on almost continuously along either bank of the river wherever local conditions as to geologic formation, elevation of sedimentary river bench land above danger from high water, steepness of banks, and bench location, such as width, accessibility, contour, and other factors warranted.

The cemetery at Wahluke contained both primary and secondary burials, but practically no other type than that of ceremonial cremation. Burials were placed in graves forming an irregular row along the river bench south of and upstream from the pit-house ruins which at one time made up a village of semisubterranean habitation structures. There is but one site known in the middle Columbia River Valley where a pit-house village had been erected above a habitation site and cemetery of an older date. This site has become known as Simmons' graveyard and is located about 5 miles downstream from Trinidad, and about 50 miles upstream from Wahluke, and several miles north of Vantage Ferry, where are located the ruins of another pit-house village and cemetery of a later date.

Cremation burials at Wahluke are usually three or more feet below the surface when undisturbed. A layer of flat stones was invariably placed in an oblong or circular ring as a protective cover against marauding animals and to prevent erosion of loose sand which forms the bench at this place. A thin covering of soil consisting of wind-blown ash, dust, and calcareous clay over compactly embedded sand makes up the formation of the village site proper.

The body to be cremated was placed on a piece of matting of Indian hemp, oriented, sometimes with the head facing upstream, sometimes toward the east, or seemingly haphazard, but always with face downward or on the side. Accompanying the burial were ceremonial offerings of personal use and ornamentation—the personal property of the deceased. The pyre was built of driftwood logs. The fire must not have been carefully attended, as many of the skeletons are merely

charred, while sections of logs, together with burial offerings of wood and objects shaped from bone, are often intact. No indication of burial houses such as were erected by tribes on the lower river were found at Wahluke or elsewhere on the middle Columbia.

Several other forms of burial were practiced both at Wahluke and elsewhere along the middle and upper Columbia River. Harlan I. Smith describes burials in domes of volcanic ash in the arid region locally known as scab land. Low knolls of but a few feet elevation composed of fine volcanic ash have been protected from the erosive action of the wind by grass clumps and sagebrush. Such domes may be the remnants of what was formerly a continuous layer of top soil, or they may have been formed as wind-blown deposits. Scab land or scab rock obtains its name from the flat fragments of basaltic rock embedded in the loess but exposed between the volcanic knolls or domes. Burials in such locations were of individuals and were accompanied with offerings of shell ornaments and of weapons. A protective circle of stones surmounts the dome burial similar to that placed on the cremation burials at Wahluke. This form of burial and other burials which were located in the talus or slide rock were observed by the writer at various locations on the sloping river cliffs but not at Wahluke. A child's grave, located on the rim elevation of a pit-house ruin, and several uncremated burials were found in the cemetery outside of the cremation row. The significance of these uncremated burials is not clear.

In some of the graves at Wahluke, skeletons were oriented in such positions as to suggest secondary burial; parts of several skeletons were jumbled in a heap and were accompanied by veritable storehouses of burial offerings. Bodies thus buried had apparently been collected from the mamalose or burial islands where they had been exposed before the ceremonial cremation burial in the village cemetery. Individual cremation burials at Wahluke usually were primary burials. Skeletal remains from such burials were found to be intact in situ except for the several parts consumed in the cremation. Such individual cremation burials were effected with knees flexed and with skull facing downward or on the side. Incineration was so complete as to prevent recovery of any one entire skeleton. Skeletal fragments, including eight skulls, were recovered from the burn, providing sufficient material for reconstruction later at the Museum. In every case the skull showed a degree of frontal-occipital deformation, which was effected by pressure from a wooden cradle-board flap placed over the forehead in infancy, a practice continued by Indian tribes of the lower Columbia Valley within historic times.

The cradle-board used by the modern Wanapûm, or Columbia River Indians does not have this wooden flap or hinged flange passing over the forehead. There is, however, among these Indians a

certain amount of flattening of the occiput due to contact of the plastic infant skull with the uncovered cradle-board. One of the more pronounced artificially deformed skulls found at Wahluke was from an uncremated burial, although some of the cremated skulls uncovered are quite similar to those of the modern brachycephalic or broad-headed Shahaptian tribes, all of which have a certain amount of occipital flattening but not of the anterior part of the skull.

One lesion of a pathologic nature in the skeletal material recovered at Wahluke was noted. This is a fusion of a lower right tibia and fibula, due probably to traumatic origin and occurring probably in sub adult life. Skulls obtained from a cemetery at Vantage Ferry, in Kittitas County, Wash., and from other burial sites farther north which were accompanied by ceremonial burial offerings of a distinctly Hudson's Bay Co. derivation were in every instance similar to those occurring in the prehistoric burials at Wahluke.

Burial offerings found among the burned charcoal and charred bones of the cremation burials at Wahluke were useful and decorative objects constituting the personal belongings of the deceased. Some of the larger pieces, such as hollowed stone bowls and long, polished stone pestles, were intentionally broken or "killed." Just one decorated stone bowl was recovered. It is a beautifully symmetrical, polished granitic piece, uniformly hollowed by pecking and crumbling with hammerstones and polished with pumice. A surface design in the form of repeated V-shape bas-relief figures made by pecking and grinding encircles the outer circumference. Paint cups and mortar bowls of stone are for the most part crudely hollowed out, although showing evidence of constant use. Paint cups still contained fragments of red and yellow ochers but no trace of a green or other colored paint. A green stain covered the surface of elk teeth and certain shell objects. This condition was caused by the penetration of copper salts from near-by copper pendants and beads and was not an intentional paint. A paint cup of *Haliotis rufescens* shell filled with red ocher used as paint was found. Most of the paint containers exhumed along the Columbia are of granitic stone or of worked pumice.

There were no wooden dishes or bowls at Wahluke. A large, flat, circular granitic mortar was picked up at the center of one of the pit-house ruins, at the location of the primitive hearth, as evidenced by the accompanying charred cooking stones of fractured red quartz and charcoal.

Pottery was neither made by the ancient occupants of Wahluke nor was its use known to them. The lack of a suitable friable potter's clay may account for this lack in part, but, as in the case of definitely developed culture complexes elsewhere, it is impossible always to explain the absence or presence of pottery, agriculture, and the loom

in terms of environmental factors. Objects recovered from graves in the cemetery and from surface finds at the site of the pit-house village of Wahluke are principally animal, vegetable, and mineral products obtained from regions near by. They consist of objects shaped from stone, bone, horn, the bark of trees, grasses, and various vegetable fibers, human and animal hair, chiefly that of the mountain sheep and of the dog. Many objects shaped from varieties of *Dentalium indianorum* and of abalone (*haliotis*) shell of the varieties *Haliotis kamchatkana*, *Haliotis fulgens*, and *Haliotis rufescens* were exhumed with the burial offerings at Wahluke. Other Pacific coast shells found in quantity in graves along the middle Columbia, especially at Wahluke, are quite distinct from the unio or fresh-water clamshell and must have been brought to the interior by direct or indirect trade with tribes of the Pacific coast, either by way of the lower Columbia River or across the mountains from Puget Sound. That few objects were found shaped from wood either of a useful or ornamental nature is noteworthy. Driftwood must have been plentiful if we are to judge from the large amount used in cremation. It is highly probable that artifacts shaped from wood might have been preserved in the burn along with basketry materials, fabrics, and objects shaped from horn and bone had they ever existed. It must therefore be concluded that burials at Wahluke antedate the highly developed technique in wood as practiced by the tribes of the lower Columbia. The more formal and conventional rectilinear art designs of the early occupants of the arid middle Columbia Valley were executed cheifly on antler and stone.

Tubular steatite pipes found at Wahluke are of two types. The one, a long tubular bowl-shaped object, entirely undecorated, obtained possibly through intercourse with California tribes; the other, a straight, small-bowled, tubular pipe with long narrow stem, etched as to bowl and stem with rectilinear ornamental designs similar to those executed on other objects from stone, bone, and horn, is undoubtedly native to the middle and upper Columbia Valley. This tubular stone pipe is identical with the native tubular pipe of southern British Columbia and of southern Idaho. Another tubular pipe found rarely is the carved bear figurine type which comes from the northwest Pacific coast tribes. A catlinite bowl pipe was exhumed which indicates influence from the East. Nephrite celts of various dimensions and with highly polished surfaces seem to suggest an important exchange of materials with tribes of British Columbia; it is possible that much of the native copper came originally from the interior of British Columbia. It is impossible to determine to what extent objects of carved stone, such as decorated pestles and tubular pipes, or of copper beads, wristlets, amulets, and bangles, or of nephrite celts, enter primitive trade as finished products. This point must be determined by urther investigation.

Species of shell from the Pacific coast other than dentalium and haliotis, perforated either at the apex or lip, were used as objects of personal adornment. Several examples mounted on necklace cords of hemp, cedar bark, and sinew were found among the burial offerings in graves at Wahluke, also at Vantage Ferry; several with fragments of cord still intact. Varieties of shell identified are *Diadora aspera*, *Olivella biplicata*, *Glycymneris subobsoleta*, and a Columbia River species of bivalve belonging to the *Protothaca*.

Among the many objects of personal adornment recovered from the cemetery at Wahluke are rectangular, perforated pendants, scrolled ear bangles, laminated wristlets, and tubular beads hammered and rolled from nuggets of native copper brought from the Cascades or obtained by barter from the coast tribes. Pendant cords of twisted fiber or of sinew were recovered only in part. Ornamental pendants and necklaces of elk and beaver teeth, hawk and eagle claws were still in situ as they were when attached to the body at the time of cremation. Such ornaments like those of horn and bone were incrusted with copper salts and thus preserved more completely than might otherwise have resulted. Etched bone tubes and gaming sticks of antler in sets of six, similar to those described by Teit and Smith from British Columbia, were exhumed.

Stone ornaments, implements, and weapon points were shaped from semiprecious agatized and petrified woods, opal, chalcedony, and jasper taken from the river bluffs 40 miles to the north beyond Saddle Mountains. Ornaments, implements, and weapon points shaped from such materials are expressions of some of the most beautiful examples of the stone-chipping art. Small, narrow-stemmed, and symmetrically worked arrow points of agate, chalcedony, carnelian, jasper, and flint were found with the burials at Wahluke.

No weapon points or chipped blades of black obsidian, which is so abundant farther south, were obtained. A chipped elongated, diamond-shape "ceremonial" object of mottled black and red obsidian, 8 inches in length, is the only specimen of obsidian obtained from burial offerings at Wahluke. Five similar "obsidian ceremonials" are represented in individual collections obtained from various sites along the middle and upper Columbia.

To convey an idea of the abundance of resources in stone and of the great variety of uses to which such material was put by the early inhabitants of Wahluke, the following list is appended.

Materials	Uses
Agatized wood	Drills; weapon points; scrapers; reamers; knives.
Agate	Drills; weapon points; scrapers; etching tools; knives.
Andesite	Fish knives; net sinkers.
Argillite	Knives; weapon points; weaving implements; beads.

Materials	Uses
Basalt	Paddle-shape blades; spindle whorls; abrasives; saws; reamers; knives; wedges; weapon points; mauls; hammers; hammerstones; bowls; paint cups; pestles.
Basalt (columnar escarpment).	Pictographs; petroglyphs; scrapers; spades.
Chrysopase	Ear pendants.
Chalcedony	Drills; scrapers; weapon points; knives; etching tools.
Diabase	Pestles; hammerstones.
Diatomaceous earth and pumice.	Abrasives.
Dyorite	Abrasives; whetstones; hammers; knives; net sinkers.
Felsite	Net sinkers.
Flint	Weapon points; drills; groovers.
Granite	Pestles; rollers; mortar stones; net sinkers; clubs; bowls; hammerstones; grooved hammers and mauls; groovers.
Greenstone	Drills; hammerstones; abrasives; smoothing stones; pestles.
Jasper	Flaked and chipped points; scrapers; etching tools; compasses; groovers; reamers; knives.
Nephrite	Adzes; celts; chisels.
Obsidian	"Ceremonials."
Opal	Weaving implements; weapon points; knives; scrapers.
Petrified wood	Drills; scrapers; perforators; weapon points; weaving implements; reamers.
Quartzite	Cooking stones; hammerstones; hammers; net sinkers; mortar stones; anchor stones; mauls; clubs; pestles.
Sandstone	Arrowshaft smoothers; bowls; abrasives; ornamental disks.
Schist (chlorite and mica)	Pipes; pendants; weaving implements; beads.
Slate	Knives; weapon points.
Steatite or soapstone	Ear ornaments; pendants; tubular pipes; beads.

All forms of the stone ax, whether a hafted hammerstone, a monolithic ax, or a grooved and bitted ax, were lacking in the surface finds, and among the grave offerings at Wahluke the aboriginal inhabitants depended on the hafted discoidal stone war club, the flaked hammerstone, the grooved maul, and the stone wedge in its stead.

Utilization of available natural resources by the sedentary, nonagricultural people of Wahluke was indeed thorough. Although the variety of such resources was limited in extent by the practically arid and barren environment, density of the aboriginal population of the middle Columbia Valley may well have been greater than that of the white race occupying the same territory within historic times. To be sure, this utilization depended on native adaptability and a knowledge of the resources afforded by the river which was near at hand and by the distant mountain forests as well.

Then, too, it must be assumed, as in the Southwest, that all vestiges of former habitation do not necessarily presuppose synchronous occupancy. If each permanent pit house village site, and each temporary fishing camp, of which traces have been found along the middle and upper Columbia, had been occupied within the period of one decade, the total native population must well have exceeded that of the white race now occupying the same territory. For example, what once were thriving Indian villages of several hundred individuals, located at two distinct sites on the Columbia at Priest Rapids, is now a practically uninhabited and for the white man an uninhabitable region. It is probable, however, that tribal warfare and habitation traditions limited the permanent native population, except during the fishing season, to small groups of Wanapûm or Columbia River Indians.

The animal resources utilized by members of this tribe as revealed in burial offerings and surface finds at Wahluke are noted in the following:

Elk (*Cervus Canadensis*)	Decorated, geometrically etched, perforate ribs used as fillets; gaff for fishhook from section of antler; weaving implement from antler; bone gouges; digging-stick handle; gaming sticks shaped from sections of antler; wedges for splitting; knives for cutting; wristlets and ornamentally incised pendants; teeth perforated for use as pendants; meat dried for food; antler for bow staves.
Deer (*Odontocoelus Americanus*)	Horn used as flaking tool, awl, weaving implement; skins used as clothing; sinew for sewing; meat used for food; sinew used to reinforce bow stave; antler used as gouge.
Dog	An extinct variety kept for the use of their shaggy coat of hair in blanket making; kept as watch dogs and used on the hunt but not eaten.
Mink (*Putorius vison*)	Fur as ornaments on headdresses.
Beaver	Fur; teeth perforated and carved as pendants; also as knives, beads.
Rabbit	Hunted for its meat; skins used in weaving blankets.
Mountain sheep (*Ovis cervina*)	Bow stave section; horn spoons.
Fresh-water clam or unio (*Protothaca* sp.).	Used as a food; shell cut and perforated for use as a pendant.
Land otter (*Lutra hudsonica*)	Quiver case.
Porcupine	Quills for ornamental display.
Bear	Teeth as pendants and weaving implement; claws as ornaments; skins as robes; as food.
Wolf and coyote	Teeth used as ornaments; skins for covering.

Long bones of various species	Marrow for oil; ornamented tubes; beads; gaming tubes; awls, wedges.
Wing bones of birds	Beads; gaming tubes; whistles.
Eagle	Feathers for headdress; for feathering arrow shaft; claw used as pendant.
Hawk	Same use as eagle feathers and claws.
Sturgeon (*Acipenser transmontanus*).	As food; dried on racks and stored.
Blue-backed salmon (*Oncorhynchus* sp.).	As food; dried on racks and stored.
Steel-head salmon (*Salmo Gairdneri*).	As food; vertebrae perforated as beads.
Trout	As food.
Eel (*Lampreta cibaria*)	Do.
Suckers	Do.
Whale	No artifacts shaped from its bones uncovered.
Bones of fish, birds, rodents and land animals.	Many undetermined uses.
Horse	No skeletal material uncovered.
Bison (*Bison Americanus*)	No skeletal material uncovered nor artifacts shaped from bison bones found.

Utilization of other natural resources as shells, berries, tubers and other vegetable or plant products, fiber plants, minerals, wood, and stone extends to a large variety of products obtained from the limited materials near at hand and to others obtained at a distance over well-defined trade or barter routes and on seasonal fishing or hunting trips.

Vegetable and plant products are represented in the finds at Wahluke as follows:

Cedar (*Thuja gigantea*)	Bark used in weaving baskets, mats, and as cord; hearth for fire making; bow stave.
Indian hemp (*Apocynum cannabinum*).	Woven fabrics and as twine.
Squaw grass (*Herophyllum tenax*)	Woven fabrics; basketry.
Cat-tail (*Typha latifolia*)	Matting and woven fabrics for floors of tipi and sweat house.
Tule (*Scirpus lacustris*)	Matting and as covering for lodges.
Elderberry	Whistles; other unknown uses, probably as ferrules, or slip collars, or sockets.
Birch-bark rolls (*Betula microphylla*).	Uses unknown.
Sagebrush	Roughly woven twined fabrics; basketry.
Willow (*Salix lasiandra*)	Framework for sweat house; basketry; bow stave.
Rye grass (*Elymus*)	Fabrics and matting.
Barley grass	Twine; fabrics; matting.
Bear grass (*Xerophyllum tenax*)	Fabrics.
Cottonwood (*Populus trichocarpa*)	Bast or inner bark used as bedding and as twine; trunks hollowed by fire into dugout canoes.

White pine (*pinus monticola*)	Firewood; canoes.
Red fir (*Pseudotsuga mucronata*)	Firewood.
Juniper (*Junipera occidentalis*)	Berries for food; uses varied.
Wild onion (*Alium geycri*)	Food.
Wild carrot (*Daucus pusillus*)	Do.
Ash wood	Used as bow staves.
Wild tobacco "kinnikkinnik" (*Valeriana edulis*).	Smoked in pipes as tobacco.
Lichen (*Alectoria* sp.)	Used as a food when stripped from bark of pine trees and boiled.
Huckleberry (*Vaccinium membranaceum*).	Used as food, both fresh and preserved.
Spruce root	As a twine and in making coiled or twined baskets.
Sunflower seed (*Helianthus* sp.)	Food.
Currant (*Ribes aureum*)	Do.
Gooseberry (and many other varieties of berries gathered in the mountains in midsummer).	Do.
Salmonberry (*Rubus spectabilis*)	Used as a food.
Wapato (*Sagittaria latifolia*)	Roots used as a food.
Kouse (*Lomatium kaus*)	Tubers used as a food in much the same manner as camas.
Camas (*Camassia esculenta*)	Tuberous roots used as food which was roasted in ovens and dried.

Habitation structures at Wahluke, as indicated by their ruins, were semisubterranean circular pit houses. They were 30 in number. No evidence remained to show the type of superstructure, as practically all of the original framework had rotted away. This condition is in striking contrast with the well-preserved artifacts of wood that were exhumed from cremation burials. Similar conditions of decay in pit-house ruins were noted at Pasco, Vantage Ferry, at the mouth of the Yakima River, and elsewhere. One possible explanation of this condition is to attribute greater age to such structures than to the cremation burials. Another more plausible explanation is that the excavations for pit-house structures are usually on a lower bench than the cemetery and that during an unusually high stage of the river were inundated, water often remaining within these pits for an entire season. Decay of all wood framework and utensils, such as were used, was inevitable. The pit house as a habitation was formerly built by peoples in British Columbia, in Alaska along the Yukon, and on the coastal islands from the Aleutians to Bering Straits, also in Siberia. This habitation structure was formerly known to groups of Plains Indians, as the Pawnee, Mandan, and others. It survives as a ceremonial chamber among the Pima, Pueblo, and certain California tribes, and as a sweat house among the Columbia River Indians.

Two such structures were observed by the writer—one at the lower falls of the Yakima River and the other at the mouth of Crab Creek.

Another form of sudatory like that of the Nez Percés, figured and described by Spinden,[5] is on the west bank of the Columbia 6 miles below the confluence of the Methow River. It is also identical with that of the Shuswap, Cree, Tinne, and other northern peoples.

The skin-covered conical tent appears never to have been introduced into the valley of the Columbia. The framework of the conical mat-covered tipi of the Columbia River tribes is probably a local development and was apparently not introduced from the Shoshoni with the horse. The difficulty encountered by the Columbia River Indians in transporting skins of the buffalo from the east, beyond the Rocky Mountains, prevented any considerable use of the products of the buffalo. Danger of contact with hostile tribes probably also prevented the acquiring of obsidian from the east, deposits of which occur at various points in the volcanic area of the Yellowstone and of the Snake River Valleys. Essential characteristics in the art designs of the ancient Columbia River Indians and in the mode of their application and execution are those of the historic Indian tribes of the middle and upper Columbia Basin. They are similar, in many instances identical, with those of the tribes of southern British Columbia on the north, the Nez Percés on the east, and in a more limited, though none the less definite manner, with those executed on certain plastic materials as sandstone, wood, and horn, by the Shoshonean and other southern stocks. Both curvilinear and rectilinear surface designs are applied by etching with bone, stone, or horn points, by rubbing, and by crumbling, though to a lesser extent also by carving out of the solid, by chipping, drilling, and by burning.

A small slab of sedimentary sandy limestone was used as a tablet by the ancient dwellers at Wahluke on which to sketch decorative surface designs resembling somewhat the veins and outline form of a lanceolate-shape leaf. No evidence was obtained that such objects had ever been worn as pendants or that they represented more than casual sketches by some artistically inclined aborigine. The etched design is identical with that described by Harlan I. Smith from a sandstone pipe of the Nez Percés.

Etched designs are more commonly applied to such media as dentalium shell and elk horn or bone than to other varieties of shell, of stone, or of wood. Rectilinear designs are commonly etched on bowls of tubular pipes of stone, also on stone weaving and plaiting implements. Etching tools are simple yet effective. Some of the more interesting and ingenious devices are two-point compasses and spaced grooving tools. A few beautiful etching tools or points of chipped jasper, chalcedony, and agate are remarkable for the almost microscopical dimensions of the working surfaces. Designs executed with

[5] The Nez Percé Indians, vol. 2, pt. 3, p. 199, Memoirs of the American Anthropological Association.

such etching tools may be seen to advantage on several dentalia shell where, through the surface etching of curvilinear lines in series and the presence of the surface in relief on intervening panels, beautiful patterns are obtained having much the appearance of an overlay twining basketry weave.

The circle and dot design is applied with the three-point compass, or with spaced grooving tools. These decorative designs are applied in series on the surfaces of bone combs, gaming sticks, tubular bone objects, and on pendants, ear ornaments, and wristlets of antler. Many surface designs were found etched or pecked on horn, shell, stone, and bone resembling conventional geometric patterns etched, incised, or pecked on similar materials by the Thompson River Indians of southern British Columbia, as described by Teit and Boas. Other surface designs resemble more those utilized in basketry decoration by the Umatilla, Wasco, and Yakima tribes. Others are entirely unique.

A wristlet of elk antler was found with triangular surface etchings built up in series of V-shape paneling entirely encircling the object. Each of the small triangular panels has as one of its sides a portion of the larger V-shape panel or triangle. The same rectilinear design appears on the surface of an overlay twined basket fashioned by the Umatilla (Cat. No. 330551 U.S.N.M.). Etched zigzag lines appear as the decorative effort on bone or stone (schistose) pendants and ear ornaments and are repeated again and again in variations of rectilinear surface decorations. Even such rare etchings and carvings of the human figure as do occur appear as rectilinear designs rather than in the more realistic curvilinear style described by J. H. Steward in the American Anthropologist.[6] The carvings from Millers Island and from the mouth of the Deschutes River belong to the coast type. When the horse was introduced from the plateau country on the south and east, the culture of the ancient Columbia River Indians became much altered. The natives were now no longer so much dependent upon the river for food and for transportation as they had been heretofore. The open country between the Snake River, which reaches the Columbia from the southeast, adjoins the territory traversed by the headwater tributaries of the Colorado. The culture of the horse increased rapidly on the Plains, after the nucleus of the herd had been formed by the few horses which escaped from Coronado's troops. Trade and intercourse with the tribes living to the east of the Columbia increased, and many features of the culture of the Plains tribes were introduced.

The absence of many objects of daily use and adornment in the culture of the Plains tribes was noted in the burials at Wahluke.

[6] "A new type of carving from the Columbia Valley," Amer. Anthrop., vol. 29, No. 2, N. S., April-June, 1927.

The lack of chipped obsidian blades and knives has been mentioned. There were no horse trappings, such as braided ropes of horsehair, nor do any rock sculptures of the figure of the horse appear anywhere except at Rock Island among the petroglyphs pecked into the crudely columnar basaltic cliffs of the Columbia River north of Wahluke, either at Vantage Ferry, Sentinel Bluffs, or Beverly. No objects made from horn of the bison were exhumed, nor were there any other indications of the use of buffalo products. There were no hafted and grooved axes; neither was there any indication in the burials that the Plains type of costume was used. Petroglyphs of the human figure on the west escarpment of the Columbia at Vantage Ferry, also at Beverly and at Sentinel Bluffs, appear to indicate, on the contrary, the use of some sort of a feathered headdress. That the practice of wearing feathered headdresses was an early one is further strengthened by the etching of a costumed human figure on a wooden comb which was exhumed at Vantage Ferry, and by a carving on wood of a fully costumed human figurine showing use of a feather headdress, exhumed at Tampico.

EXPLANATIONS OF PLATES

Unless otherwise noted, all objects described are from Wahluke, Wash.

PLATE 1

Hand Pestles of Stone

No. 1. Large pestle of vesiculate basalt shaped by pecking and crumbling. The pestle is symmetrical in outline and shows tapering from center of shaft upward. Top section has been broken off. Two parallel decorative grooves encircle the pestle at a distance of 11.5 cm. (4.5 in.) from the base. Incised grooves are 1 cm. apart and are each ½ cm. deep. Dimensions: 21 cm. (8.3 in.) long; 7 cm. (2.7 in.) basal diameter. Collection of H. T. Harding, Walla Walla, Wash.

No. 2. Flat-sectioned pestle of calcareous sandstone. Tapered shaft; bulbous enlargement of basal end. Cap section has shallow cleft at center. Shaped by pecking with celt or hammerstone and smoothing with pumice. Dimensions: 16.5 cm. (6.5 in.) long; 7 cm. (2.8 in.) wide at base. Other stone pestles found at Wahluke have decorative heads showing more deeply incised cleft. Cat. No. 333581, U.S.N.M.

No. 3. Hand pestle pecked from native greenstone. Tapered circular walls somewhat flattened at sides due to limitations in size of bowlder from which pestle has been shaped. Characteristic basal section and irregularly shaped enlargement at top. Found with burial offerings in grave 1. Dimensions: 18 cm. (7.1 in.) long; 10 cm. (4 in.) basal diameter; diameter of head cap 5 cm. (2 in.). Cat. No. 333578, U.S.N.M.

No. 4. Hand pestle of diabase. More symmetrical in shape than No. 3. The bulbous basal section is short; tapered walls are slightly convex; cap section is symmetrically rounded and convexly beveled at the top. Dimensions: 16.5 cm. (6.5 in.) long; 8.5 cm. (3.3 in.) in diameter at base. Cat. No. 331995, U.S.N.M.

No. 5. Decorated head of pestle of worked diabase. Polished surface; carved image of animal figure forms the cap or head section; the figure has been shaped out of the solid, while features as mouth and eyes are indicated by incised lines; the eye is represented by the circle and dot design. Dimensions: Diameter of pestle head, 7 cm. (2.8 in.). Cat. No. 333593, U.S.N.M.

No. 6. Cigar-shape hand pestle of smoked granodiorite. Surface symmetrically rounded by pecking and beveled to tapering top and basal sections, with greatest diameter near basal end. Similar pestles of greenstone in graves at Wahluke are larger and have polished surfaces, which this pestle does not have. Cat. No. 333587, U.S.N.M. Exhumed from grave 2. Dimensions: 20 cm. (7.9 in.) long; 6 cm. (2.4 in.) greatest diameter.

No. 7. Small pestle of worked diabase. Pecked into a concavely beveled cylinder with no basal extension or knob at the top. From grave 3. Dimensions: 10 cm. (4 in.) long; 5 cm. (2 in.) diameter. Cat. No. 333585, U.S.N.M.

No. 8. Small plummet-shape hand pestle of calcareous sandstone. A decorative design of beveled encircling rings and intervening pecked grooves forms the head or knob. Side walls are beveled to form a bulbous base. Dimensions: 12.3 cm. (4.9 in.) long; 5 cm. (2 in.) wide.

No. 9. Decorative knobbed head of pestle shaped from diabase. The surface is polished and symmetrically rounded. Neither this head nor those of Nos. 5 and 8 are as characteristic of the stone pestles of Wahluke as are Nos. 2–4, and 6. Grave find. Dimensions: 7.5 cm. (2.9 in.), diameter of knobbed head; distance from rim of knob to tip, 6 cm. (2.4 m.); diameter of shaft below rimmed knob, 5.5 cm. (2.2 in.). Cat. No. 333594, U.S.N.M.

Plate 2

Types of Arrow and Spear Heads

No. 1. Arrowhead of red jasper. Triangular shape with slightly convex lateral edges. Deeply concave base. Stem has straight sides and base chipped to a thin edge with cleft at center. Dimensions: 4.4 cm. (1.7 in.) long; 3.6 cm. (1.4 in.) wide at base. Grave find. Cat. No. 333947, U.S.N.M.

No. 2. Arrowhead of smoky reddish-white translucent agate. Barbed; straight base with cleft; obliquely chipped facets. Found at mouth of the Deschutes River by H. T. Harding. Dimensions: 5.6 cm. (2.2 in.) long; 2.6 cm. (1 in.) wide.

No. 3. Triangular arrowhead of smoky chalcedony. Deeply concave lateral edges and base; no stem. Dimensions: 4.8 cm. (1.9 in.) long from wing tip to point. Found near Castlerock on the Cowlitz River, Wash. Cat. No. 317360, U.S.N.M.

No. 4. Long arrowhead of brownish black and white agatized wood. Lanceolate leaf shape; concave base chipped to thin edge; no stem. Columbia River beach, near Trinidad, Wash. Dimensions: 6.7 cm. (2.5 in.) long; 3.1 cm. (1.2 in.) wide. Cat. No. 333941, U.S.N.M.

No. 5. Arrowhead of flint. Ovoid; stem has expanding sides and straight thin-edged base; irregularly chipped facets. Dimensions: 6.5 cm. (2.5 in.) long; 3.5 cm. (1.4 in.) wide. Cat. No. 317360, U.S.N.M.

No. 6. Arrowhead of gray flinty quartz. Thick sectioned, leaf shape; convexly rounded edges slightly constricted at neck, terminating in wide stem with thick sectioned unchipped base. Dimensions: 8.2 cm. (3.2 in.) long; 3.2 cm. (1.3 in.) wide. Cat. No. 317360, U.S.N.M.

No. 7. Arrowhead of gray flint. Triangular in shape; blunt of point with concave base; no stem. Dimensions: 3.7 cm. long; 2.9 cm. wide at base. Cat. No. 317359, U.S.N.M.

No. 8. Arrowhead of dull red jasper. Triangular; concave base chipped to thin edge; no stem. Grave 3. Dimensions: 4.6 cm. (1.8 in.) long; 3 cm. (1.2 in.) wide. Cat. No. 333941, U.S.N.M.

No. 9. Long, narrow arrowhead of agate. Triangular in shape, with long, acute point and concave base. Stem has expanding edges and straight base. Symmetrically chipped surfaces. Exhumed with burial offerings from grave 4. Dimensions: 7.8 cm. (3 in.) long; 2.2 cm. (0.9 in.) wide at base. Cat. No. 333944, U.S.N.M.

No. 10. Spear point of grayish white flint. Triangular in section; edges parallel near base, which is straight; no stem. In collection of H. T. Harding from beach of Columbia River 2 miles below Vulcan, Wash.

No. 11. Leaf-shape flint arrowhead. Convexly rounded edges of point and stem. From the Cowlitz River, near Castlerock. Cat. No. 317360, U.S.N.M.

No. 12. Arrowhead of agatized wood. Ovoid, leaf shape; base is concavely rounded and chipped to thin edge. No stem. Collection of H. T. Harding, from Vulcan, Wash. Dimensions: 6.8 cm. (2.7 in.) long, 4.2 cm. (1.6 in.) wide

No. 13. Chipped spear point of translucent brown agate. Oval in shape with concave base; no stem; obliquely chipped facets. Dimensions: 10.5 cm. (4.1 in.) long; 4 cm. (1.6 in.) wide; 0.9 cm. sectional thickness. Cat. No. 333850, U.S.N.M.

No. 14. Chipped spear point of reddish gray flint. Roughly triangular in shape with edges slightly rounded near point; convex base has wide crescentic cleft at center chipped to thin edge, although unchipped and thick sectioned on the obliquely truncated portions near edges. Dimensions: 9.9 cm. (3.8 in.) long; 4.4 cm. (1.7 in.) wide. Cat. No. 333852, U.S.N.M.

No. 15. Chipped arrowhead of crystalline quartz with opaline incrustations. Triangular in shape, with edges rounded near weapon point. Crescentic, unchipped, truncated base cut into three sections by two narrow obliquely chipped clefts which form a central stem with expanding edges. Dimensions: 7 cm. (2.7 in.) long; 3.4 cm. (1.3 in.) wide. Cat. No. 333947, U.S.N.M.

Plate 3

Types of Arrowheads

No. 1 Thick-bodied arrow point of whitish yellow jasper. Triangular, with slightly convex rounded edges; base, straight; stem, long necked with expanding sides. Dimensions: 3.1 cm. (1.2 in.) long; 2.4 cm. (0.9 in.) wide; 0.9 cm. thick. Cat. No. 333943, U.S.N.M.

No. 2. Thin sectioned arrowhead of black slate. Rough granular surface, irregularly chipped. Bilaterally cleft near base for cross lashing of sinew in hafting; base concave; no stem. Dimensions: 4.1 cm. (1.6 in.) long; 1.9 cm. (0.8 in.) wide. Cat. No. 333949, U.S.N.M.

No. 3. Arrowhead of gray flint. Oval shape with acute point; bilaterally cleft for diagonal lashing of sinew seizing. Base, straight. Dimensions: 4.1 cm. (1.7 in.) long. Found in grave on Cowlitz River near Castlerock. Cat No. 317360, U.S.N.M.

No. 4. Arrowhead of dull red jasper with incrustation of agate at tip. Uniformly chipped to a beveled section with high mid section. Oval in outline; nocked at the edges near base for diagonal lashing of sinew in hafting. Base, straight, chipped to a thin edge. Dimensions: 3.8 cm. (1.5 in.) long; 2.7 cm. (1.1 in.) wide. Cat. No. 333943, U.S.N.M.

No. 5. Thick sectioned arrowhead of opaque black obsidian. Oval shape; base, straight. Stem has expanding sides and straight base. Dimensions: 3.7 cm. (1.5 in.) long; 2 cm. (0.8 in.) wide. Cat. No. 333943, U.S.N.M.

No. 6. Triple bilaterally barbed arrowhead of reddish brown jasper with incrustations of agate. Narrow cleft base. Dimensions: 5 cm. (2 in.) long; cm. (0.8 in.) wide. Cat. No. 333947–R, U.S.N.M.

No. 7. Arrowhead of smoky white chalcedony. Leaf shape, with elongated neck constriction and flaring bilateral wing barbs. Base, concave. Dimensions: 3.8 cm. (1.5 in.) long; 1.4 cm. (0.5 in.) wide. Cat. No. 333947–T, U.S.N.M.

No. 8. Arrowhead of reddish white mottled chalcedony. Triangular; deeply concave base inset with stem with expanding sides and straight base. Dimensions: 4 cm. (1.6 in.) long; 2.4 cm. (0.9 in.) wide. Cat. No. 333944, U.S.N.M.

No. 9. Long, narrow-bodied arrowhead of chocolate-brown agate. Facets chipped obliquely to high mid section. Base, straight; stem has convex base and expanding sides. Dimensions: 5 cm. (2 in.) long; 1 cm. (0.4 in.) wide. Cat. No. 333948, U.S.N.M.

No. 10. Arrowhead of red jasper with opaline incrustations. Oval shape, serrated edges; convexly rounded base. Surface shows evidence of much

rechipping. Dimensions: 5.5 cm. (2.2 in.) long; 2 cm. (0.8 in.) wide. Cat. No 333947–S, U.S.N.M.

No. 11. Long, narrow-bodied arrowhead of smoky white agate. Slightly oval outline; base, straight inset with lenticular, diamond-shaped stem. Dimensions: 5 cm. (2 in.) long; 1.4 cm. (0.5 in.) wide. Cat. No. 333947–K.

No. 12. Arrowhead of gray flint. Triangular; irregularly chipped surfaces; thick-sectioned body with straight base; stem, wide with expanding sides and deeply cleft base for the diagonal cross lashing of seizing sinew in haftings. Dimensions: 5 cm. (2 in.) long; 2 cm. (0.8 in.) wide. Cat. No. 333947–A.

No. 13. Arrowhead of yellow jasper. Triangular; wide stem, with expanding sides, inset in deeply concave base. Diagonally laid on notches separating base from stem are designed for use in hafting arrow shaft. Dimensions: 3.6 cm. (1.4 in.) long; 2.7 cm. (1.1 in.) wide. Cat. No. 333947–A.

No. 14. Chipped arrowhead of glassy moss agate. Triangular; diagonally laid notches at base; stem has expanding sides and straight base. Found by H. T. Harding on beach of Columbia River 2 miles above Sandy Point, Grant County, Wash. Dimensions: 3.5 cm. (1.4 in.) long; 2.2 cm. (0.8 in.) wide.

No. 15. Arrowhead of pinkish white jasper. Triangular, with convexly rounded sides. Base, straight; long-necked stem with concavely rounded edges expanding at base, where it is chipped thin for hafting. Dimensions: 4.4 cm. (1.7 in.) long; 2.2 cm. (0.8 in.) wide. Exhumed by H. T. Harding at mouth of Deschutes River, Oreg.

No. 16. Arrowhead of creamy gray jasper mottled with red. Lanceolate leaf shape; irregularly serrated rechipped edges; thick sectioned. Stem is wide and has expanding sides and straight thick base. Dimensions: 4.6 cm. (1.8 in.) long; 2. cm. (0.8 in.) wide. Found on beach at mouth of Deschutes River. Cat. No. 333943, U.S.N.M.

No. 17. Arrowhead of opaque creamy white jasper. Triangular, with flaring wing barbs at base. Base is deeply concave and has a stem or nock of even proportions. Chipped facets are regularly transverse, producing serrations on lateral edges. Dimensions: 4.3 cm. (1.7 in.) long; 2.2 cm. (0.8 in.) wide at base. Cat. No. 333944, U.S.N.M.

No. 18. Arrowhead of cream colored jasper. Long, narrow body with evenly chipped serrated edges; convexly rounded base terminating in pointed stem or tang at the center. Goldendale, Wash. Collection of H. T. Harding. Dimensions: 4.9 cm. (1.9 in.) long; 1.4 cm. (0.5 in.) wide.

No. 19. Arrowhead of creamy white jasper. Triangular, flat section obliquely laid notches near edges, and wide stem with expanding edges and rounded concave base at center of base. Dimensions: 3.9 cm. (1.5 in.) long; 1.9 cm. (0.7 in.) wide. Cat. No. 333947–A, U.S.N.M.

No. 20. Arrow point of light brown jasper. Thick-sectioned, evenly chipped, serrated edges terminating in bilaterally chipped barbs at base. Base is convexly rounded, terminating in inversely triangular stem or nock for hafting. Dimensions: 4.6 cm. (1.8 in.) long; 1.7 cm. (0.7 in.) wide. Cat. No. 333939, U.S.N.M.

No. 21. Chipped arrowhead of red jasper. Narrow body with flaring bilaterally laid wing barbs at base. Base is deeply concave and is inset with stem of uniform width. Dimensions: 3.9 cm. (1.5 in.) long; 2 cm. (0.8 in.) wide at base. Cat. No. 333944, U.S.N.M.

No. 22. Arrowhead of slaty gray diabase. Triangular sectioned, with two pairs of bilateral, obliquely laid barbs, separated by wide notches for diagonal lashing of sinew in hafting. Base is concave and is chipped to thin edge. Dimensions: 3 cm. (1.2 in.) long; 2.3 cm. (0.9 in.) wide at base. Cat. No. 333947–I, U.S.N.M.

No. 23. Arrowhead of red jasper. Long, narrow, thick section; serrated edges. Base, straight; stem has straight sides and is rounded at base. Dimensions: 4 cm. (1.6 in.) long; 1.3 cm. (0.5 in.) wide at base. Cat. No. 333939, U.S.N.M.

No. 24. Arrowhead of glassy, translucent, smoky chalcedony with mottlings of agate at tip. Thin sectioned, finely chipped over all. Transversely deeply chipped notches laid at the edges near base, forming bilateral wing barbs. Base is concave and is chipped to thin edge. This arrowhead and the previously described No. 23 and No. 9 are the more characteristic types at Wahluke. Dimensions: 3.7 cm.(1.5 in.) long; 1.2 cm. (0.5 in.) wide. Cat. No. 333949, U.S.N.M.

No. 25. Arrowhead of mottled agate. Triangular, thin in section; straight base cleft with notch at its center; transverse notches are chipped at sides near the base for lashing seizing of sinew in hafting. Dimensions: 3.1 cm. (1.2 in.) long; 2 cm. (0.8 in.) wide at base. Cat. No. 333947–G.

Plate 4

Hammerstones and Scaling Knives

No. 1. Hammerstone of andesite, with weathered natural lateral surfaces. Flakes have been struck off at the edges from either side entirely around the circumference. Found on river beach below site of village located on the bench above. Dimensions: 14.5 cm. (5.7 in.) diameter, 3.3 cm. (1.3 in.) thick. Cat. No. 333627, U.S.N.M.

No. 2. Hammerstone of weathered greenstone. Oblong and roughly rectangular in section. The edges are abraded and crudely flaked at one end, also half the distance of one lateral edge. Found on beach below village. Greenstone pestles and celts are uniformly highly polished and symmetrically finished. This object shows no evidence of intentional working either on lateral surfaces or edges. Dimensions: 19.8 cm. (9.6 in.) long; 2.8 cm. (1.1 in.) thick; 9.4 cm. (2.5 in.) wide. Cat. No. 333560, U.S.N.M.

No. 3. Rectangular worked hammerstone of reddish-brown quartzite. Surface is naturally smooth due to weathering except at the edges, sides, and on one end where intentional fracturing and abrasion by use are shown. The section at center shows less fracturing and is expanded, giving the hammerstone an oblong lenticular diamond-shape appearance. Surface find near cemetery. Dimensions: 15.6 cm. (9.1 in.) long; 5.7 cm. (2.2 in.) wide; 3.5 cm. (1.4 in.) thick. Cat. No. 333557, U.S.N.M.

No. 4 Crudely fractured hammerstone of reddish quartzite. One of the many similar unworked tools fractured through use. This object and many similar hammerstone and cooking stones were found on the high bench land above cemetery site. Dimensions: 13.3 cm. (5.3 in.) long; 10 cm. (3.9 in.) wide; 6.5 cm. (2.5 in.) thick. Cat. No. 333564, U.S.N.M.

No. 5. Unworked hammerstone of metamorphic greenstone. Smooth surfaces except at ends which show abrasion by use. Found on beach below village site. Dimensions: 10.1 cm. (4 in.) long; 7.1 cm. (2.3 in.) wide; 4.5 cm. (1.7 in.) thick. Cat. No. 333562, U.S.N.M.

No. 6. Scaling knife of andesite. A flat, circular, water-worn pebble which has been given rectangular form by use and some additional intentional bilateral chipping at edges. Removal of facets by fracturing has provided four cutting edges at right angles. Chipping of edges is bilateral and uniform. Surface find on beach below village site. Dimensions: 9 cm. (3.5 in.) diameter; 1.5 cm. (0.6 in.) sectional thickness. Cat. No. 333618, U.S.N.M.

No. 7. Scaling knife of basalt. Weathered flat surfaces of pebble bilaterally chipped and fractured at two opposite edges only, providing but two cutting

edges, in contrast with the four cutting edges of No. 6. Other similar flat surfaced rectangular scaling knives have three cutting edges. Dimensions: 9.7 cm. (3.8 in.) diameter. Cat. No. 333623, U.S.N.M.

No. 8. Flaked sandstone knife. This oval form of stone flake is used as a general utility knife and is essentially a flake struck off a larger core by fracturing. A large flake has been struck off the mid section and there is rechipping entirely around the circumference on one side only. Beach surface find. Dimensions: 10.3 cm. (4 in.) long; 5.9 cm. (2.3 in.) wide; 2.4 cm. (0.9 in.) thick. Cat. No. 333625, U.S.N.M.

No. 9. Oval-shaped blade or scraper from a core of diorite. Reverse lateral surface is sand weathered with chipped and flaked edges; obverse surface has been shaped by fracturing over all and by rechipping entirely around the circumference. Dimensions: 10.7 cm. (4.2 in.) long; 9.9 cm. (2.7 in.) wide; 2.4 cm. (0.9 in.) thick. Cat. No. 333626, U.S.N.M.

No. 10. Scaling knife or scraper of brown sandstone. This form of flake knife is similar to No. 8, and is itself a flake from a larger core. A large flake has been struck off its exposed or weathered surface by fracturing from one edge. Surface find. Dimensions: 13 cm. (5.1 in.) long; 5.9 cm. (2.3 in.) wide. Cat. No. 333612, U.S.N.M.

No. 11. Worked oblong granitic pebble used as scaling knife or scraper. Natural, smooth, weathered lateral surfaces fractured on longitudinal edges but not at the ends by intentional bilateral pecking and further abraded by use. Surface find on beach below village site. Dimensions: 18.9 cm. (7 in.) long; 8.9 cm. (3. 5 in.) wide; 5 cm. (2 in.) thick. Cat. No. 333558, U.S.N.M.

Plate 5

Objects of Personal Adornment

No. 1. Rectangular slab of argillite probably used as a mirror. Edges have been worked and corners rounded. No etched figures appear on the lateral surfaces, nor is there a perforation for suspension. Surface find on cemetery site. Dimensions: 4.6 cm. (1.8 in.) long; 3.1 cm. (1.2 in.) wide; 0.3 cm. sectional thickness. Cat. No. 333688, U.S.N.M.

No. 2. Lump of copper carbonate and malachite found with the burial offerings in grave 3. This material is not copper but occurs naturally between layers of mineral rock. Used probably as a paint ingredient.

No. 3. Lump of red ocher found in grave 4. There was no paint cup found near the object. The ocher crumbles easily and must have produced a very effective paint. Dimensions: 4.1 cm. (1.6 in.) long; 3.1 cm. (1.2 in.) wide. Cat. No. 333669, U.S.N.M.

No. 4. Fragment of yellow ocher. Found in grave 5 with other burial offerings. Dimensions: 4.8 cm. (1.9 in.) long; 2 cm. (0.8 in.) wide. Cat. No. 333669, U.S.N.M.

No. 5. Pendant of abalone shell (*Haliotis rufescens*). Perforated for suspension at one end near center by drilling; perforation is of uniform diameter. The edges of the shell have been cut to the form of a rectangle, rubbed at the ends and rounded at the corners. Incised marginal etchings in series of three and five appear at one lateral edge. Dimensions: 12 cm. (4.7 in.) long; 6.3 cm. (2.5 in.) wide; 0.7 cm. sectional thickness. Collected by H. T. Harding at the railroad terminal in Wenatchee, Wash. Probably part of an exposed burial offering.

No. 6. Chalcedonic notched pendant or scraper. Found at Lyons Ferry near Almonta, on the Snake River. Lateral edges have been chipped to thin surfaces and are convexly rounded in shape. There is evidence of rubbing through use. End sections are concave, forming grooves for hafting or for cross lashing of

sinew cord for suspension. Dimensions: 2.7 cm. (1.1 in.) wide; 2.5 cm. (1 in.) long.

No. 7. Hammered nugget of native copper used probably as an amulet. Lateral surfaces have been flattened by cold hammering and the edges are quite irregular. These irregular edges have been used as a hafting hold for the suspension cord of twisted fiber, probably Indian hemp. Two strands of this cord appear in crosswise lashing at the center of object. They have become mineralized through impregnation with copper salts. Found with burial offerings in grave 1. Dimensions: 5.5 cm. (2.2 in.) long; 1 cm. (0.4 in.) sectional diameter. Cat. No. 333700, U.S.N.M.

No. 8. Fragment of pendant of abalone (*Haliotis rufescens*) shell. The fragment has a circular beveled perforation drilled bilaterally for suspension. Found in grave 3. Cat. No. 333680, U.S.N.M.

No. 9. Ear pendant of abalone (*Haliotis kamchatkana*) shell. Perforated for suspension near margin and at center. The edge has incised serrations extending around the circumference. There is one incomplete perforation near margin. This variety of Haliotis has a corrugated, convex, reddish tinged outer surface and a typically blue-green concave inner surface; it is an unusual variety among shell offerings in burials. Dimensions: 3.5 cm. (1.4 in.) in diameter. Cat. No. 333681, U.S.N.M.

No. 10. Perforated shell bead. (*Glycymneris subobsoleta* Carpenter.) A flat shell peforated at apex for suspension. Found with burial offerings in grave 7. Dimensions: 2 cm. diameter. Cat. No. 333739, U.S.N.M.

No. 11. Bead, perforated; cut from leg bone of a bird. Convexly rounded outer surface. 1 cm. in diameter; 0.8 cm. diameter of perforation. Cat. No. 333690, U.S.N.M.

No. 12. Bone bead from perforated wing bone of a bird. Roughly triangular in section. Worked on both inner and outer surfaces. Cat. No. 333690, U.S.N.M.

No. 13. Perforate shell bead of *Glycymneris subsobsoleta*. Illustration shows perforation at apex similar to that of No. 10. Diameter of shell, 2.4 cm. (0.9 in.). Cat. No. 333739, U.S.N.M.

No. 14. Chipped stone drill or pendant. The object is ovoid and has neck constriction terminating in a three-faceted point. Dimensions: 3.8 cm. long; 1.8 cm. wide.

No. 15. Bead or pendant from claw of an eagle or hawk. Stained a light green by contact with oxidizing copper in burial offerings. 4.1 cm. long. Cat. No. 333890, U.S.N.M.

No. 16. Discoidal bead of steatite. Circular stone bead perforated at center hourglass fashion with a bilateral bevel from center. Irregularly cut outer circumference. Dimensions: 0.8 cm. diameter; 0.3 cm. sectional thickness.

No. 17. Small shell (*Olivella biplicata*) perforate for suspension at basal end for suspension in line with natural opening at the end fold or apex of shell.

No. 18. Discoidal shell bead cut from a bivalve species of protothaca or clamshell. Bilaterally beveled perforation at center. Dimensions: 1 cm. diameter; 0.2 cm. thickness; 0.3 cm. diameter of perforation. Cat. No. 333691, U.S.N.M.

No. 19. Shell bead of *Diadora aspera*, pierced at apex for suspension. Dimensions: 2.3 cm. (0.9 in.) greatest diameter; 1.2 cm. thickness. Cat. No. 333740, U.S.N.M.

No. 20. Large *Olivella biplicata* shell bead perforated like No. 17. Cat. No. 333741, U.S.N.M. Dimensions: 2 cm. (0.8 in.) long; 1.3 cm. (0.5 in.) diameter.

No. 21. Elk-tooth bead perforate for suspension.

No. 22. Bear-tooth bead perforate for suspension at end of root. The perforation is drilled and is of uniform width throughout.

Plate 6

Decorated Objects of Stone, Bone, Horn, and Wood

No. 1. Section of carved deer horn from which fibrous core has been removed. Exhumed from burial at Vantage Ferry, Kittitas County, Wash. This carved fragment is similar to the carved antler animal figures obtained by H. I. Smith, at Lytton, British Columbia. Use unknown. Dimensions: 16.3 cm. (6.4 in.) long; 5 cm. (2 in.) wide; 0.3 cm. thick. Cat. No. 330820, U.S.N.M.

No. 2. Decorated pendant of stone (mica schist). Elongated oval shape flat lateral surfaces; thin in section. Perforation for suspension near smaller end is cut hourglass fashion at a bevel from both obverse and reverse sides. Transversely incised parallel decorative lines. Dimensions: 9.3 cm. (3.6 in.) long; 6 cm. (2.4 in.) wide.

No. 3. Weaving heddle of rectangular slab of mica schist. The object shows much evidence of use in the abraded surface near the lower end. Incised on the obverse lateral surface are decorative designs resembling figures of plants and of leaves. Found by H. T. Harding 2 miles below Vulcan in burial offerings; 9 cm. (3.5 in.) long.

No. 4. Tubular bone object. Incised parallel grooved lines encircle circumference at either end near margin and one at the center. Dimensions: 4.4 cm. long; 1.4 cm. diameter.

No. 5. Rectangular slab of carved wood decorated with incised punctated designs. Identical number of punctations appear on each of the four lateral surfaces. Dimensions: 4.7 cm. (1.9 in.) long; 0.9 cm. sectional diameter.

No. 6. Decorated bone object. Edges are cut in roughly rectangular form, representing a garment. Extensions which had been cut at the sides near the top margin have rotted away or have been broken. The punctated design consisting of two parallel rows of incised dots probably represent beads of elk teeth. Found in grave 2. Dimensions: 9.1 cm. (3.6 in.) long; 3.6 cm. (1.4 in.) wide. Cat. No. 333928, U.S.N.M.

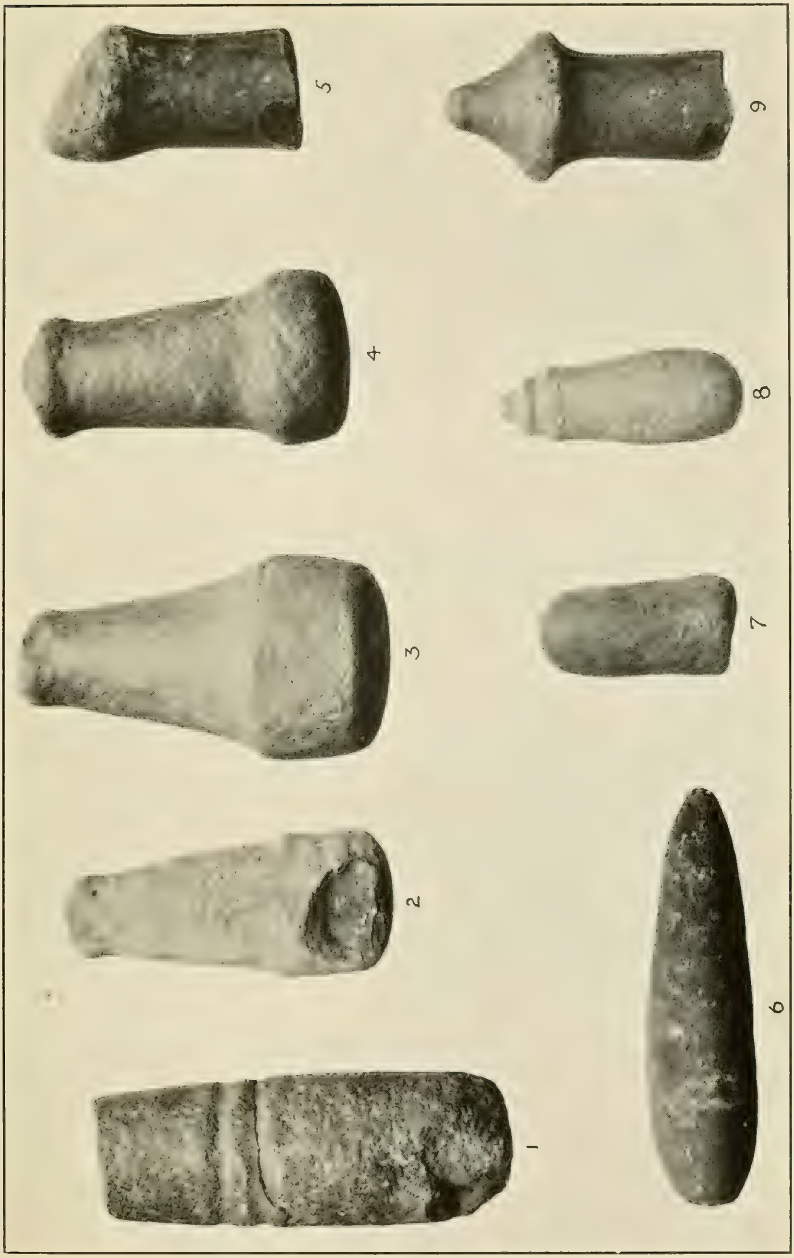
No. 7. Carved and decorated comb of wood. The figure consists of a convexly triangular base which is perforated near the apex, and of eight teeth, each of which are broken off. Incised lines appear in parallel combined with the circle and dot design on the reverse side. The obverse has the figure of a woman appareled in a fringed garment etched on the surface. The comb, as it appears with teeth broken off, is 3.2 cm. (1.3 in.) wide; 0.5 cm. thick; and 8 cm. (3.2 in.) long.

Nos. 8, 10–12. Gaming sticks of bone or horn. These objects were much charred or burned in the cremation fire and have become very brittle. The decorative designs are etched on one lateral surface only, the reverse smooth surfaced. The sticks are oblong and are tapered toward each end. The etched designs are in the form of punctations, each from one to two tenths centimeters in depth, and in series of etched parallel zigzag lines in duplicate, triplicate, and in series of four. Dimensions: 8–9 cm. (3–3½ in.) long; 1–1½ cm. wide. Cat. Nos. 333661–333665, U.S.N.M.

Plate 7

Western end of White Bluffs escarpment at Wahluke, Grant County, Wash. The point where the Columbia River strikes these bluffs may be seen in the vertical, eroded walls of the escarpment on the right. The vegetation in the foreground is sagebrush; most of the grasses formerly occupying this area have disappeared within historic times. The ancient village of Wahluke is on the right and does not appear in this picture.

The Columbia River at Wahluke. White Bluffs appear in the background, extending from the extreme left to the distant right. The pit house village ruins are in the foreground and are covered in part with driftwood from the extremely high flood waters of the Columbia River which covered the site in 1894. The cemetery is on the right in the foreground and does not appear in the illustration. It is located on higher bench land and has never been covered with the flood waters of the Columbia. The western extension of White Bluffs where it joins with Saddle Mountains is on the left and does not appear in the illustration.

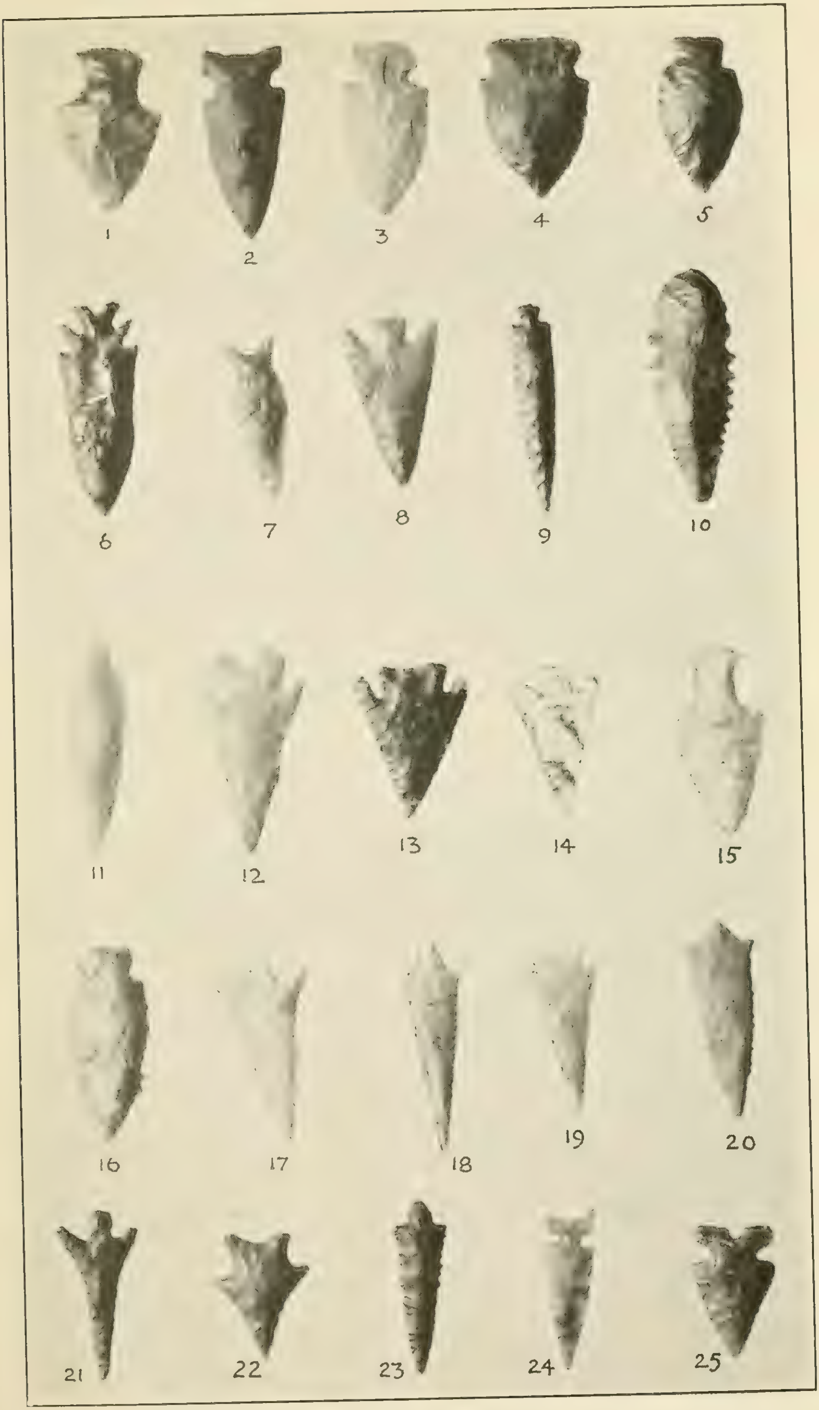


HAND PESTLES OF STONE

FOR EXPLANATION OF PLATE SEE PAGES 21 AND 22

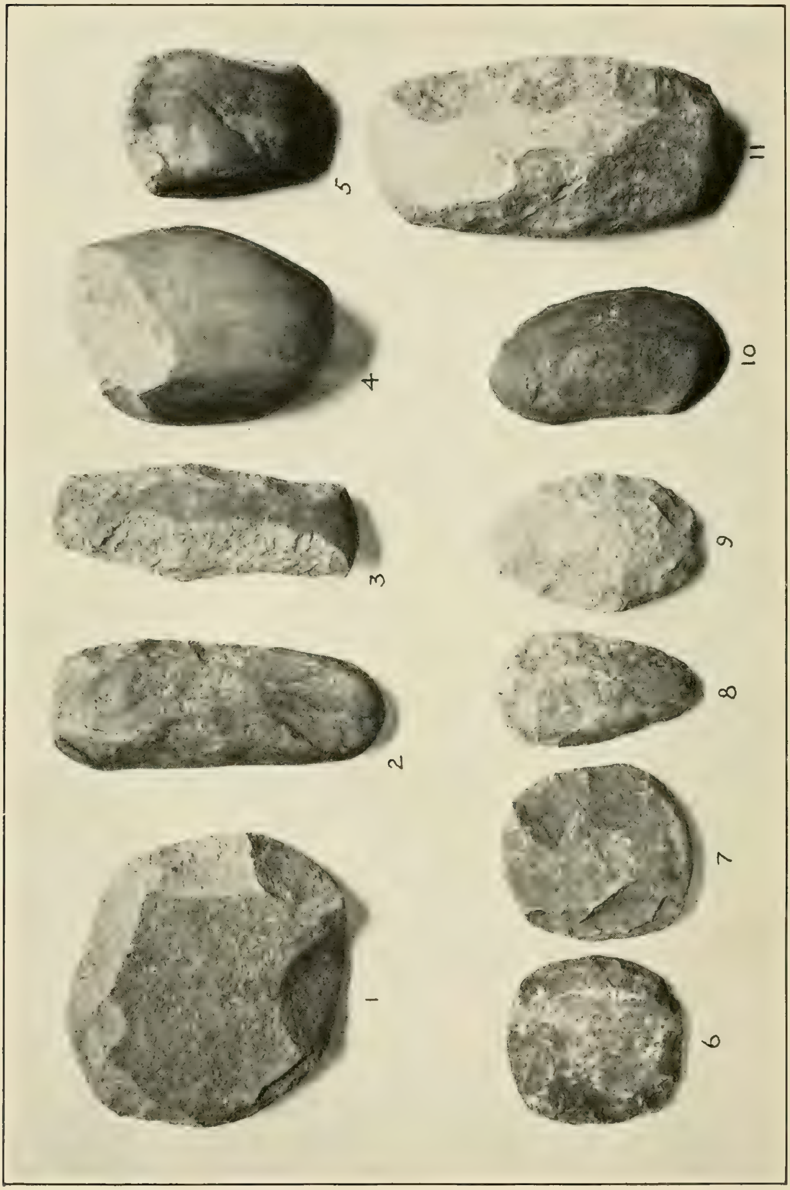
TYPES OF ARROW AND SPEAR HEADS

FOR EXPLANATION OF PLATE SEE PAGES 22 AND 23



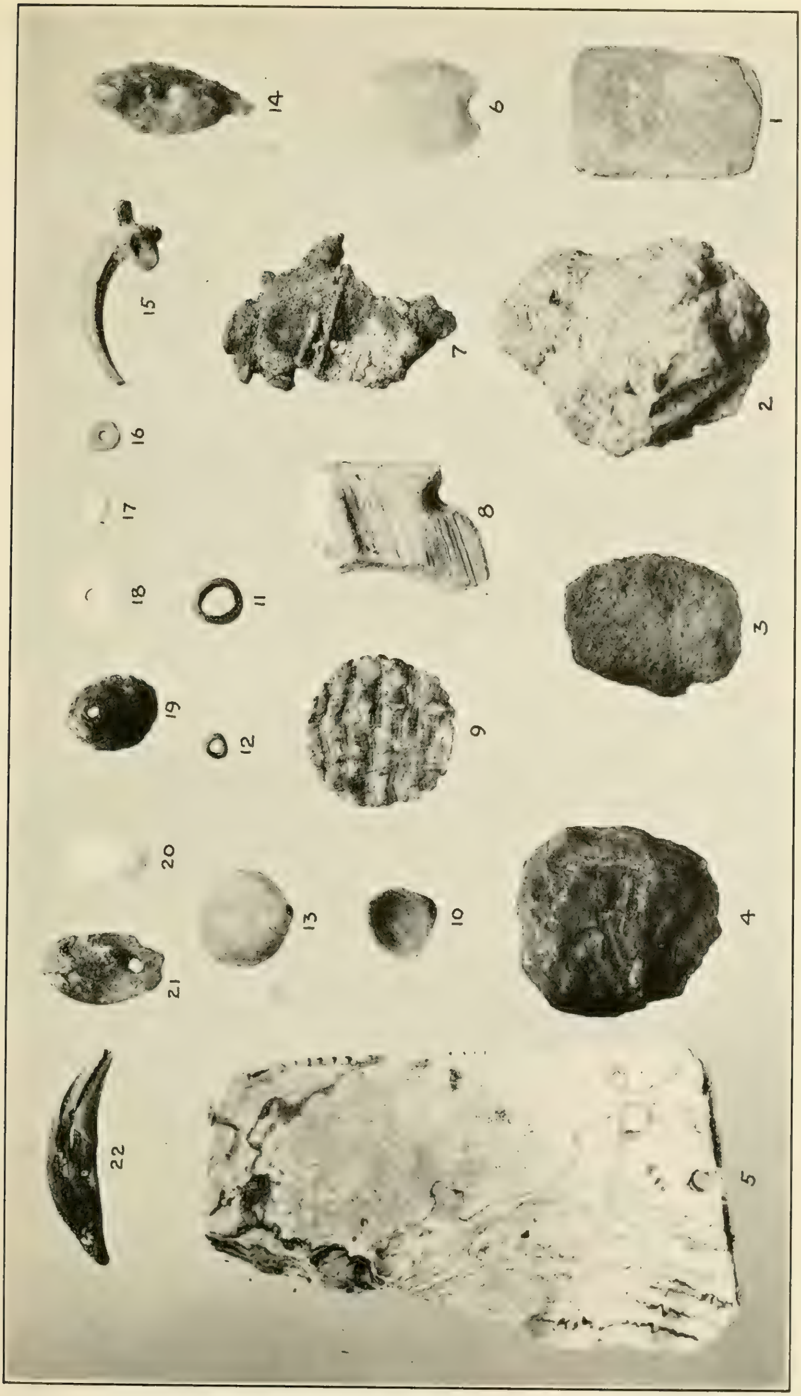
TYPES OF ARROWHEADS

FOR EXPLANATION OF PLATE SEE PAGES 23 TO 25



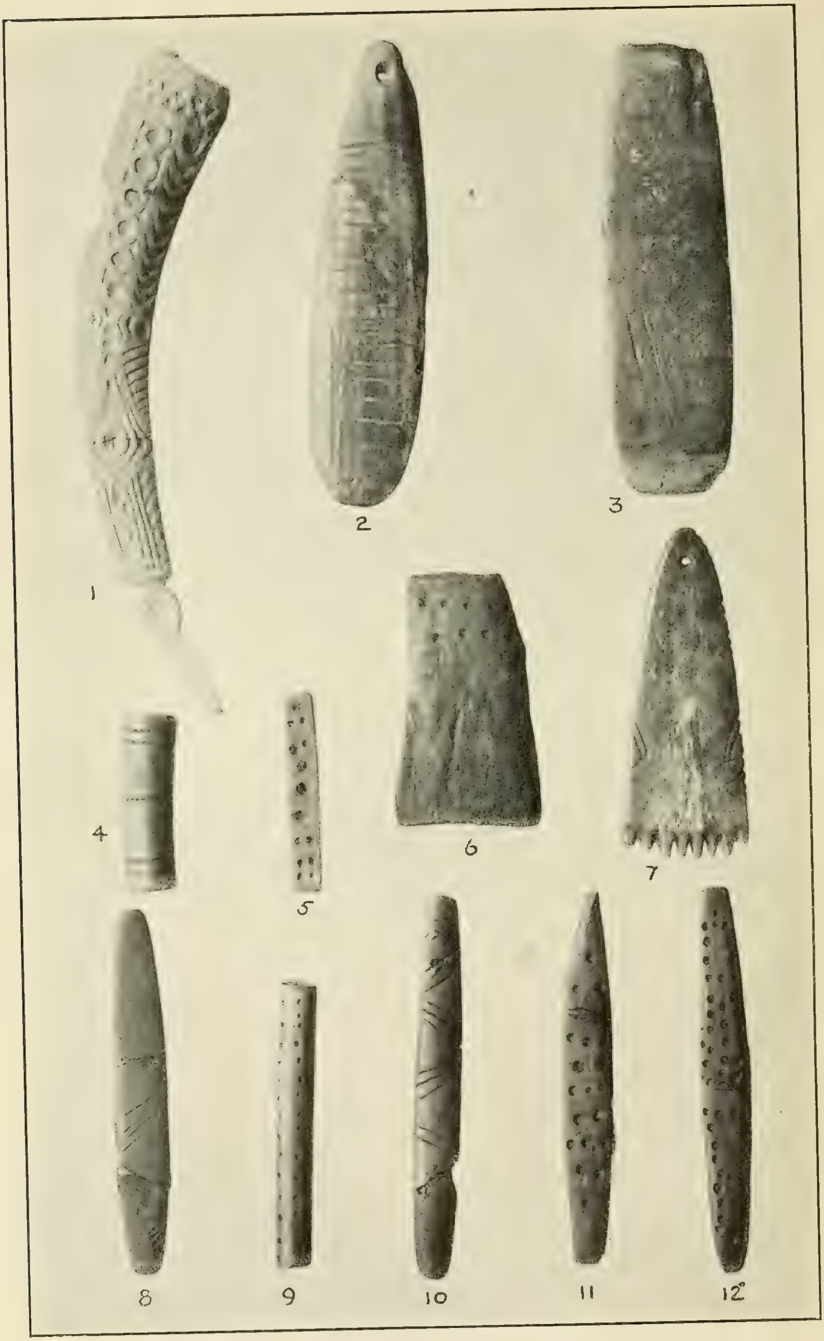
HAMMERSTONES AND SCALING KNIVES

FOR EXPLANATION OF PLATE SEE PAGES 25 AND 26



OBJECTS OF PERSONAL ADORNMENT

FOR EXPLANATION OF PLATE SEE PAGES 26 AND 27



DECORATED OBJECTS OF STONE, BONE, HORN, AND WOOD

FOR EXPLANATION OF PLATE SEE PAGE 28

WHITE BLUFFS ESCARPMENT AT WAHLUKE, WASH.

THE COLUMBIA RIVER AT WAHLUKE, WASH.

FOR EXPLANATION OF PLATE SEE PAGES 27 AND 28

A REVISION OF THE LIZARDS OF THE GENUS CTENOSAURA

By John Wendell Bailey
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INTRODUCTION

A few years ago Dr. Thomas Barbour, of the Museum of Comparative Zoölogy, in reporting on "Some Reptiles From Old Providence Island"[1] made the following statement concerning the genus *Ctenosaura:*

> A single young *Ctenosaura* was obtained, which certainly is closely related to *C. completa* Bocourt. It is, however, not improbably distinct and undescribed. The genus *Ctenosaura*, however, is in quite a chaotic condition, but it can not be revised to meet the modern requirements of the discriminating systematist until the types of the early authors can be examined; and in this case the types are widely scattered in various European museums.

Later Doctor Barbour took up the question of this genus with Dr. L. Stejneger, curator of the division of herpetology at the United States National Museum, receiving in response to his inquiries the the following letter:

> Some time ago you asked my opinion as to *Ctenosaura cycluroides* and others, but frankly I am as much in a quandary as you. Many years ago I tried to get light on the question, but gave up in despair, waiting till I should get more material. In the course of time quite a number of specimens have accumulated, of the group Boulenger calls *C. acanthura*, certainly over 150—many very large specimens, and of these many not too well preserved. However, I have not had the courage to tackle them again. I had come to a tentative conclusion at the time, based chiefly on the characters of the verticils of the tail, which seem more reliable than those of the spines on the vertebral line, but I could not make up my mind which was the real *C. acanthura*, which I think can only be ascertained from an examination of the type in London.

Shortly after the receipt of the above letter by Doctor Barbour the writer matriculated in the graduate school at Harvard University, and immediately fell heir to the "*Ctenosaura* problem," a task that has been difficult and at times discouraging, yet very pleasant because of the friendly interest manifested by coworkers in this country and in Europe.

[1] Barbour, T. Proc. New Engl. Zool. Club, vol. 7, pp. 81-85, May 6, 1921.

This paper is based upon the collections in the British Museum of Natural History, London; des Naturhistorischen Museums, Hamburg; Zoölogisches Museum, Berlin; Museum d'Histoire Naturelle de Paris; California Academy of Science, San Francisco; American Museum of Natural History, New York City; United States National Museum, Washington, D. C.; and the Museum of Comparative Zoölogy, Cambridge, Mass., altogether a large and representative series indeed.

Two new species are described, one, *Ctenosaura parkeri*, from Barranca Iberra, Jalisco, Mexico, is dedicated to H. W. Parker, herpetologist, British Museum of Natural History, through whose kindness the writer was enabled to examine the important types in England. Two visits to the United States National Museum in Washington made it possible to study the types there. The second new species, *clarki*, is dedicated to Dr. Herbert C. Clark, director of medical research and laboratories, United Fruit Co., through whose interest and efforts the various collections at the Museum of Comparative Zoölogy have been augmented from time to time. With the exception of *Cyclura* (*Ctenosaura*) *teres*, which was described from a living specimen, by Harlan in 1824, and of which there is no record of its ever having been preserved, and *Iguana* (*Ctenosaura*) *similis*, Gray, which was at one time in the Bell Museum, London, but subsequently disappeared, the type specimens of every form referred to the genus have been carefully studied.

To the following persons the writer wishes to offer his sincere thanks for valuable aid in the preparation of this revision: Mr. H. W. Parker, London; Dr. George Dunker, Hamburg; Dr. Ernest Ahl, Berlin; Dr. F. Angel, Paris; Dr. L. Stejneger and Miss Doris M. Cochran, Washington; Mr. J. R. Slevin, San Francisco; and Dr. Thomas Barbour, Cambridge, Mass.

ABBREVIATIONS

M. C. Z -------- Museum of Comparative Zoölogy, Cambridge, Mass.
A. M. N. H ----- American Museum of Natural History, New York, N. Y.
U. S. N. M------ United States National Museum, Washington, D. C.
Brit. Mus------- British Museum of Natural History, London, England.
C. A. S--------- California Academy of Science, San Francisco, Calif.
M-------------- Male.
F-------------- Female.
A-------------- Adult.
Y-------------- Young.
H-grown-------- Half grown.

GENERAL CONSIDERATIONS

The genus *Ctenosaura* includes 13 species of lizards, the distribution of which is confined to Mexico and Central America. In the West Indian region their place is taken by the genus *Cyclura*, to

which some of the earlier described species of *Ctenosaura* were assigned. The two genera are very closely related, but may be readily distinguished from each other by a comparison of the soles of the hind feet; in *Cyclura* there are peculiar corneous combs or pectinations on the under side of the toes; the toes of *Ctenosaura* are without such corneous combs.

The species are powerful and very active, and can make a good defense when necessary by the use of their small sharp teeth, and of their spinose tail. This organ is armed with whorls of spinous scales which are very acute and which inflict considerable wounds when driven against the naked surface of the skin. Ctenosaurs are not much valued as food by the natives of Mexico and Central America, except by some Indians, and like other large tree and rock lizards are called iguanas.

We know very little if anything of the geologic history of this genus, and one simply gropes in the dark in attempting to treat of this phase of the subject. However, a few facts relative to the family Iguanidae, to which this genus belongs, will be given merely to throw some light on the possible origin and distribution of the group. All of the Iguanidae are confined to North and South America with the exception of one genus (*Brachylophus*) which inhabits the Fiji Islands and two others (*Chalarodon* and *Hoplurus*) living in Madagascar. A fossil species of iguana (*Iguana europaea*) has been described from the Eocene deposits of France and England. The Cretaceous genera *Iguanavus* and *Chamops* from Wyoming have always been considered as belonging to the Iguanidae, so there is no reason to doubt that the family has originated in America and that it was present during the latter part of the Mesozoic era.

Although no very satisfactory conclusions, perhaps, can be reached regarding the main question of the origin of the species of *Ctenosaura*, the data derived from this study indicate very strongly the close relationship to, and their origin from, a common iguanid stock. Also from the present distribution of the species it seems but logical to believe that they originated at some place in central western Mexico, probably Nayarit and Jalisco, and that they have spread thence northward and southward until they cover practically the whole of Mexico and Central America. The transition in morphological characters has been gradual, and there is no obvious break in the series, indicating, of course, land migration only.

By a strange coincidence the type, *Ctenosaura acanthura*, is both the most primitive and the most widely distributed species of the genus, and evidently had, at an early date, firmly established itself throughout Mexico, being numerous on both the east and west coasts. Even to-day this species has practically the same distribution.

The presence of several species within a short radius makes it impossible to determine the origin of the various species. The order of arrangement of the species in this paper has been made with regard to structural relationship and not according to geographical distribution or to any supposed origin.

During the lower and upper Cretaceous, the upper Eocene and the early Oligocene periods what is now the peninsula of Lower California was a part of the mainland of Mexico, the present Gulf of California being dry land. Some of the members of this tribe of lizards migrated northward and westward, away from the foothills of the mountain ranges, finding their way to the semiarid desert regions of the Pacific coast, what is now the Cape St. Lucas region of Lower California. During the late Oligocene period the land between the desert region and the mountain foothills became submerged, creating the present Gulf of California. The ctenosaurs that were then shut off from their kindred on the mainland became adapted to the deserts, undergoing of course a few minor changes such as would aid in the preservation of the species. The chief changes were in the shortening of the dorsal crest, both in the length of the individual spines and also in the extent of the crest on the back. Color markings were effected to give greater protective resemblance; resemblance to the speckled and splotched habitat of the species. This species is called *Ctenosaura hemilopha.* Its present range is the entire southern half of Lower California and most of the islands near the peninsula, in the Gulf of California. A few individuals have been collected just across the gulf in Sonora, and as far north as Nogales, Ariz. They were in all probability carried there by man; but it is not impossible that their ancestral stock wandered there before the submergence of the Gulf of California.

In the immediate vicinity of the center of distribution of the genus four species have arisen. They probably arose in the following order: *brachylopha, brevirostris, pectinata,* and *parkeri.* As the original stock, *acanthura,* continued its migration southward, other species appeared; *clarki* and *quinquecarinata.* South of the Isthmus of Tehuantepec *acanthura* is replaced entirely by *similis,* a very active form which is abundant throughout Central America as far south as Panama. As the lizards continued their southward migration, new conditions in their surroundings led to new structural adaptions. A change in color took place, transverse stripes becoming conspicuous, and these probably serve, as in the case of the tiger, to aid in the concealment of their possessor. This coloration is associated with changes in habits in Central America. Three other smaller species, *bakeri, palearis,* and *defensor,* each with a very restricted habitat, have also arisen in this territory, all coming perhaps from similis; *bakeri* is restricted to Utilla Island, Honduras, *defensor* to northern Yucatan, and *palearis* to the

semidesert plateau region just south of the Motogua River in Guatemala. The distribution of *erythromelas* is unknown. Part of the *acanthura* group upon reaching the Isthmus of Tehuantepec turned north, following the foothills of the mountain ranges along the east coast of Mexico, where they have been collected as far north as Tamaulipas.

Early writers placed members of this genus in various genera. Shaw called his type *Lacerta acanthura.* Merrem called the same species *Uromastyx acanthurus*, while most of the early authors placed all these lizards in the genus *Cyclura.* The genus *Ctenosaura* was erected by Wiegmann in 1828, based upon *Ctenosaura cycluroides* (*Ctenosaura acanthura*), collected in Mexico by F. Deppe. Although the exact locality of Deppe's specimens is not known, it is thought that they were taken near Vera Cruz, his first landing and collecting place in Mexico.

In the spring of 1828 Deppe accompanied Doctor Schiede to Mexico, primarily to collect botanical specimens for the museum at Berlin. Zoological material was collected also, and some of the mammals, birds, and reptiles were described by Lichtenstein in 1838 and 1854. Their work was confined chiefly to eastern and southern Mexico, but some collections were made on the west coast by Deppe.

Schiede and Deppe landed at Vera Cruz and after spending several weeks in that vicinity proceeded to Jalapa, where they arrived in early August. They left Jalapa November 28 for Papantla and Misantla. While in this vicinity they collected on Orizaba and Cofre de Perote. Writing under date of October 26, 1829, from the City of Mexico,[2] Doctor Schiede stated that Deppe left him at Jalapa with the intention of going to California by way of Acapulco, but that he was prevented from carrying out his plans and was in the City of Mexico when he (Schiede) arrived. Schiede died about 1836 and after his death Deppe went on to California, probably by way of Acapulco and thence by vessel to Monterey or San Francisco, as he had originally planned. Early in the following year, 1837, he visited the Sandwich Islands, where he was with J. K. Townsend in Honolulu. The same year he returned to his home at Charlottenburg, about 1 mile from Berlin, where he remained until his death in 1861.

The collector and date of collection of Shaw's *Ctenosaura acanthura* are unknown, but the collection was made prior to 1802, the time the description was published. It was evidently collected in Mexico, where it is still not uncommon, since its habitat, the coastal region, is very large and contains much unsettled territory. The species *hemilopha* is common in the cape region of Lower California, while *brachylopha* is limited to southern Sinaloa, the islands, and the

[2] Linnaea, vol. 5, p. 477.

mainland of Nayarit. It was taken as late as 1913 at San Blas, Nayarit, by J. C. Thompson. The species *brevirostris* and *pectinata* range from Nayarit southward to Oaxaca, in company with other species of the genus, while *parkeri*, a new species, is described from specimens from Barranca Iberra, Jalisco. However, its distribution extends to Nayarit, specimens having been taken at Tres Marias by M. Forrer about 1885. The species *quinquecarinata* is known only from Tehuantepec, Oaxaca, while *clarki* has been collected at only one known locality—Ovopeo, Michoacan. The form *defensor* is very rare and has been taken only in Yucatan, but *similis* is very common throughout southern Mexico and Central America, including Panama, and is perhaps the most abundant species of the genus.

Slight variations occur throughout the genus, not only in the species but even in the individuals. It is not at all uncommon to find specimens having a different number of femoral pores on the two legs. The femoral pores are much larger in the males than in the females. Glands at the base of these pores, in both sexes, produce a brown waxy secretion which hardens and protrudes from the openings. Although its function is unknown it appears to be most conspicuous during the mating period, and it may have some significance in that connection. Furthermore, the femoral pores are not always limited to one row. Individuals have been examined in which the pores numbered 7 on each side, 5 in one row and 2 in a second row, parallel to the first. Another specimen having 7 femoral pores on each side had 6 in one row and 1 in the second-row position. Both sides were patterned alike. The number of spines or lobes making up the dorsal crest also varies considerably with the species and sex. These dorsal crest spines are larger in the males than in the females. Age also causes a difference in the size of the dorsal crest—the older specimens possessing the tallest crest.

Individuals have been examined in which the number of small flat scales separating the whorls of large spinous scales on the upper half of the tail differ on the right and left sides of the central row of caudal spines. Sometimes the first and second whorls are separated by two rows of flat scales, the second and third whorls by two rows on the right and three on the left; and occasionally one of the spinous whorls is omitted on one side, giving that side twice as many, plus one or two additional, flat scales. This arrangement of the scales does not appear to be due to the loss of any, but merely to their disarrangement, for in the succeeding rows the "omitted" scales are found crowded in; thereby evening the count on both sides of the dorsal row. The greatest variations are to be found in the coloration of the individuals. This question is discussed under the respective species involved, especially in *hemilopha* and *similis*, so it is sufficient to say at this point that the young and adults differ very greatly in coloration—

the young as a rule being more or less greenish, while the adults become darker and often marked with black or brown. In very old specimens the color oftentimes becomes a reddish or rusty brown or even black. Both young and old of some species have spots and stripes. The great number of synonyms found in this genus are probably due, at least in part, to the lack of a proper consideration of these variations.

At the beginning of this study it was thought that possibly there were some osteological characters upon which this and nearly related genera might be definitely separated. However, a careful examination of *Iguana*, *Ctenosaura*, and *Cyclura* shows only slight differences in the skull, and even these differences can not possibly be called generic differences. As a matter of fact, the only differences are to be found in the general outline of the skull, and these are no greater between genera than between species of the same genus. The skull of *Iguana* and *Cyclura* are typically iguaniform in size and shape, while in *Ctenosaura pectinata* and *similis* the skull is slightly elongated and flattened dorso-ventrally. Yet in *brevirostris* the rostrum, as indicated by the specific name, is short; the skull is not flattened but would pass for a true *Iguana*. It is impossible to distinguish between the genus *Ctenosaura* and its near allies by means of skeletal characters.

The early and most primitive forms of these lizards had very elongated tails and bodies—the true reptilian type, so to speak. Thus *acanthura*, supposedly the most primitive of the living forms of the genus, has a very long tail. It appears that as this form migrated the tail has tended to become shorter. It is interesting to note that along with the reduction in the length of the tail there is a corresponding increase in the size of the caudal spines. Also the species possessing the largest spines have the smallest bodies. The large spines on the tail will probably help to protect the species from enemies, while the small size of the body renders it undesirable as food for man, the most relentless enemy of these large lizards.

Genus CTENOSAURA Wiegmann

Type.—*Ctenosaura cycluroides* Wiegmann, 1828, Oken's Isis, p. 371 (*Ctenosaura acanthura*).

Ctenosaura WIEGMANN, 1828, Oken's Isis, p. 371.—GRAY, 1845, Cat. Lizards Brit. Mus., p. 191.—BOCOURT, 1870, Miss. Sci. Mex., vol. 3, Reptiles, p. 136.—COPE, 1885, Proc. Acad. Nat. Sci. Philadelphia, vol. 23, p. 262.—BOULENGER, 1885, Cat. Lizards Brit. Mus., vol. 2, p. 195.—COPE, 1886, Proc. Amer. Philos. Soc., vol. 23, p. 216; 1887, Bull. 32, U. S. Nat. Mus., p. 33.—GÜNTHER, 1890, Biol. Centr. Amer., Reptiles, Batrachia, p. 50.—COPE, 1900, Report U. S. Nat. Mus. for 1898, p. 237.—BROWN, 1904, Proc. Acad. Nat. Sci. Philadelphia, vol. 56, p. 468.—DITMARS, 1907, Reptile Book, p. 106; 1910, Reptiles of the World, pp. 140–141.—BARBOUR, 1916, Bull. Mus. Comp. Zoöl. (Part), vol. 60, No. 4, p.

140.—STEJNEGER and BARBOUR, 1917, Check list N. Amer. Amph. Rept., ed. 1, p. 44; 1921, Proc. New Eng. Zoöl. Club, vol. 7, p. 82.—VAN DENBURGH, 1922, California Acad. Sci. Oc. Papers No. 10, Reptiles of West. N. Amer., vol. 1, p. 64.—STEJNEGER and BARBOUR, 1923, Check list N. Amer. Amph. Rept., ed. 2, p. 42.

Uromastyx MERREM, 1820, Tent. Syst. Amph. (Part), p. 56, 1820.—GRAY, 1845, Cat. Lizards Brit. Mus., p. 191.

Cyclura HARLAN, 1824. Journ. Acad. Nat. Sci. Philadelphia, vol. 4 (Part), p. 250.—GRAY, 1827, Philos. Mag., ser. 2, vol. 2, p. 57 (Part).—WIEGMANN, 1834, Herp. Mex., pp. 15, 41 (Part).—DUMÉRIL et BIBRON, 1837, Erpét. Gén., vol. 4, p. 214–244 (Part).—FITZINGER, 1843, Syst. Rept., p. 56 (Part).—GRAY, 1845, Cat. Lizards Brit. Mus., vol. 2, p. 190 (Part).—COPE, 1868, Proc. Acad. Nat. Sci. Philadelphia, p. 283 (Part).—HEILPRIN, 1882, Proc. Acad. Nat. Sci. Philadelphia, p. 333 (Part).—CHAPMAN, 1891, Proc. Acad. Nat. Sci. Philadelphia, p. 366 (Part).

Enyaliosaurus GRAY, 1845, Cat. Lizards Brit. Mus., p. 192.

Cachryx COPE, 1866, Proc. Acad. Nat. Sci. Philadelphia, p. 124.—COPE, 1885, Proc. Acad. Nat. Sci. Philadelphia, vol. 23, pp. 262–270.—BOULENGER, 1885, Cat. Lizards Brit. Mus., vol. 2, pp. 195–198.

Diagnosis of the genus.—The members of this genus have the tail armed with strong spinous scales; tympanum distinct, nearly as large as orbit. The body is scarcely compressed; the scales of the median dorsal row enlarged, forming a dorsal crest. Scales of head and body small, those of the belly being smaller than those of the upper head, and those of the back being smaller than those of the belly. A very strong transverse gular fold, except in two species in which there is a large nondilatable longitudinal gular fold, the dewlap. There is a short series of femoral pores. Mandibular and maxillary teeth pleurodont, the lateral teeth only with denticulated crowns; pterygoid teeth present. The tongue is short and thick and slightly notched anteriorly, nonprotractile. Digits compressed, with keeled lamellae inferiorly, but without corneous combs or pectinations on the toes.

Of the 27 species that have been described only 13 are valid. They are *C. acanthura* (Shaw), 1802; *bakeri* Stejneger, 1901; *brachylopha* (Cope), 1866; *brevirostris* Cope, 1886; *clarki* Bailey, 1928; *defensor* (Cope), 1866; *erythromelas* Boulenger, 1886; *hemilopha* (Cope), 1863; *palearis* Stejneger, 1899; *parkeri* Bailey, 1928; *pectinata* Wiegmann, 1834; *similis* (Gray), 1831; *quinquecarinata* (Gray), 1842. These, may be separated by the use of the following key to the species:

KEY TO THE SPECIES OF CTENOSAURA

A¹.—Median row of dorsal scales enlarged and extending from nape to end of tail, without interruption at the sacrum. These scales are usually large and armed with heavy spines, more pronounced in the males than in the females. Over the sacrum the crest consists of slightly raised and enlarged scales without spines.

B¹.—Head very short, rostrum conspicuously decurved________**brevirostris**

B².—Head normal, rostrum not conspicuously decurved.

C¹.—First six whorls of spinous scales of the tail separated from each other by four or more rows of small, flat, smooth scales___**parkeri**

C².—First six whorls of spinous scales of the tail separated from each other by fewer than four rows of small, flat scales.

D¹.—The first and second or the first, second, and third whorls of spinous scales separated from each other by two or three rows of small, flat scales, the next six or eight whorls being separated from each other by two rows of small, flat scales, body marked with black cross bands terminating on belly **similis**

D².—First five or six whorls of spinous scales separated from each other by three rows of smaller scales, the next five or six whorls being separated from each other by two rows of smaller, flat scales. No such black bands as in D---**pectinata**

A².—Median row of dorsal scales low and interrupted at the sacrum, not continuous as in A¹.

B¹.—Median row of dorsal scales extending only one-fourth to one-half distance to sacrum, and not noticeably raised.

C¹.—Tail armed with 13 to 20 whorls of heavy spinous scales not interspaced with whorls of small flat scales--------------**defensor**

C².—Tail armed with whorls of spinous scales, which are interspaced with one row of small flat scales.

D¹.—Row of small flat scales very conspicuous throughout length of tail-------------------------------------**clarki**

D².—Row of small flat scales barely detectable on basal half of tail, but noticeable on distal half-----------**erythromelas**

B².—Median row of dorsal scales extending to or almost to sacrum, noticeably raised, of medium height.

C¹.—First two or more whorls of caudal spinous scales separated from each other by one row of small flat scales.

D¹.—Males and females possessing very pronounced dewlap **palearis**

D².—Not possessing dewlap but having transverse gular fold **quinquecarinata**

C².—Proximal whorls of caudal spinous scales separated by two or more rows of small flat scales.

D¹.—First, second and third worlhs of caudal spinous scales interspaced with two rows of small flat scales, the next five or six whorls with one row of small flat scales.

E¹.—Small dewlap present--------------------------**bakeri**

E².—No dewlap, transverse gular fold present, back marked with prominent black blotches or spots----**hemilopha**

D².—First three or more whorls of caudal spinous scales interspaced with three or more rows of small flat scales.

E¹.—First and second or first, second and third whorls of spinous scales interspaced with three rows of small flat scales--------------------------------**acanthura**

E².—First, second, third, fourth, and fifth whorls of spinous scales interspaced with three rows of small flat scales **brachylopha**

DISCUSSION OF THE SPECIES

CTENOSAURA ACANTHURA (Shaw)

Plates 1, 2, 3, 4

Lacerta acanthura SHAW, 1802, General Zoology, vol. 3, p. 1, p. 216.—GRAY, 1827, Philos. Mag., ser. 2, vol. 2, p. 57.

Uromastyx acanthurus MERREM, 1820, Tent. Syst. Amph., p. 56.

Cyclura teres Harlan, 1824, Journ. Acad. Nat. Sci., Philadelphia, vol. 4, pp. 242–251, pl. 26.—Garman, 1884, Bull. Essex Inst., vol. 16, p. 19.

Ctenosaura cycluroides Wiegmann, 1828, Oken's Isis., vol. 21, p. 371.—Bocourt, 1874, Miss. Sci. Mex., Reptiles, vol. 3, p. 143.—Sumichrast, 1880, Bull. Soc. Zoöl. France, vol. 5, p. 174.—Ives, 1891, Proc. Acad. Nat. Sci., Philadelphia, vol. 43, p. 459.—Brown, 1908, Proc. Acad. Nat. Sci., Philadelphia, vol. 60, p. 117.

Cyclura carinata Wagler, 1830, Nat. Syst. Amph., p. 147.

Iguana (*Ctenosaura*) *armata* Gray, 1831, Cuv. Griff. Anim. Kingd., vol. 9, Synopsis, p. 38.

Iguana (*Ctenosaura*) *belli* Gray, 1831, Cuv. Griff. Anim. Kingd., vol. 9, Synopsis, p. 38.

Iguana (*Ctenosaura*) *lanceolata* Gray, 1831, Cuv. Griff. Anim. Kingd., vol. 9, Synopsis, p. 38.

Cyclura articulata Wiegmann, 1834, Herp. Mex., pp. 42–43.

Cyclura denticuláta Wiegmann, Herp. Mex., pp. 42–43.—Hallowell, 1854. Proc. Acad. Nat. Sci., Philadelphia, vol. 7, p. 103.

Cyclura (*Ctenosaura*) *shawii* Wiegmann, Herp. Mex., pp. 42–43.—Fitzinger, 1843, Syst. Rep., p. 56.

Cyclura semicristata Fitzinger, 1843, Syst. Rep., p. 56.

Cyclura (*Ctenosaura*) *articulata* Fitzinger, 1843, Syst. Rep., p. 56.

Cyclura (*Ctenosaura*) *belli* Fitzinger, 1843, Syst. Rep., p. 56.

Cyclura (*Ctenosaura*) *denticulata* Fitzinger, 1843, Syst. Rep., p. 56.

Cyclura denticulata Hallowell, 1855. Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 3, p. 36.

Cyclura acanthura Sumichrast, 1864, Arch. Sci. Phys. Nat., vol. 19, pp. 49–50; 1864, Ann. Mag. Nat. Hist., vol. 13, p. 500.—Cope, 1871, Proc. Acad. Nat. Sci., Philadelphia, pp. 205–216; 1874, Journ. Acad. Nat. Sci., Philadelphia, ser. 2, vol. 8, pp. 95–124; 1879, Proc. Amer. Philos. Soc., vol. 18, p. 261; 1885, Proc. Amer. Philos. Soc., vol. 22, p. 379.

Ctenosaura acanthura Gray, 1845, Cat. Lizards Brit. Mus., p. 191.—Cope, 1866, Proc. Acad. Nat. Sci., Philadelphia, p. 124.—Sumichrast, 1880, Bull. Soc. Zool. France, vol. 5, p. 175.—Boulenger, 1885, Cat. Lizards Brit. Mus., vol. 2, p. 195.—Günther, 1890, Biol. Cent. Amer., Rept. Batr., p. 5.—Ditmars, 1910. Reptiles of the World, p. 141.

Cyclura (*Ctenosaura*) *acanthura* Cope, 1869, Proc. Amer. Philos. Soc., vol. 6, p. 161.

Ctenosaura teres Bocourt, 1874, Miss. Sci. Mex., Reptiles, vol. 3, p. 142.—Cope, 1886, Proc. Amer. Philos. Soc., vol. 23, pp. 266–268; 1887, Bull. 32, U. S. Nat. Mus., p. 34.—Van Denburgh, 1897, Proc. Acad. Nat. Sci., Philadelphia, vol. 49, p. 461.—Cope, 1900, Rept. U. S. Nat. Mus. for 1898, p. 238.

Cyclura (*Ctenosaura*) *cycluroides* Garman, 1884, Bull. Essex Inst., vol. 16, No. 1, p. 19.

Cyclura (*Lacerta*) *acanthura* Garman, 1884, Bull. Essex Inst., vol. 16, No. 1, p. 19.

Ctenosaura multispinis Cope, 1885, Proc. Amer. Philos. Soc., vol. 23, p. 197 (part); 1886, p. 266–267; 1887, Bull. 32, U. S. Nat. Mus., p. 34; 1900, Rep. U. S. Nat. Mus. for 1898, p. 237–240.—Ditmars, 1907, Rept. Book, p. 107.—Stejneger and Barbour, 1917, Check-List N. Amer. Amph. Rept., ed. 1, p. 44.—Van Denburgh, 1922, Occ. Papers California Acad. Sci., No. 10, vol. 1, Lizards, p. 64–66.—Stejneger and Barbour, 1923, Check-List, N. Amer. Amph. Rept., ed. 2, p. 42.

Type.—Brit. Mus. Nat. Hist. No. XXII 20–*a*, Female.

Type locality.—Restricted to Tampico, Tamaulipas, Mexico.

Diagnosis.—A conspicuous transverse gular fold; median dorsal scales 65–80, considerably larger than body scales forming a serrated crest of slight elevation extending from the beginning of the neck to the sacrum; dorsal crest not even indicated by a row of carinated scales in sacral region. Tail very long and strongly marked into numerous verticilli (whorls or rings), composed of very long and very strongly carinated scales, each terminating in a lengthened point, thereby causing a spiny appearance throughout entire length of tail; whorls of spinous scales separated from each other by rows of smaller flat scales; first and second or first, second, and third whorls separated by three rows of smaller flat scales; next five or six whorls separated by two rows of smaller flat scales; a few whorls separated by one row of flat scales, these flat scales gradually becoming spinous until at or near middle of tail small flat scales disappear and tail exhibits a spiny appearance to end. (Of course a broken tail that has been regenerated does not possess the armed scales on the regenerated portion.)

Distribution.—This ctenosaur has the widest distribution of any member of the genus. It ranges from the States of Sonora and Chihuahua, Mexico, southward to the Isthmus of Tehuantepec, inhabiting sandy beaches and the foothills of the various mountain ranges. Most of the specimens that have been collected have been taken on the coastal slopes of the mountain ranges, very few being recorded from the interior regions. Specimens taken on the islands in the Gulf of California and at Cape St. Lucas, Lower California, were in all probability carried over from the mainland. These lizards are regarded as food by some Indians and are often carried alive from place to place for that purpose.

Many specimens in the museums in this country and in Europe bear simply the locality label "Mexico." However, enough properly labeled material has been examined to insure accurate distribution charts. Specimens have been taken at Batopilas, Chihuahua, Mexico; on the western foothills of the Sierra Tarahumare Mountains; Tampico and Manuel, Tamaulipas; Miramar, Cerro del Gallo, Jalapa, and Panuco, Vera Cruz; Escuinapa and Tres Marias Island, Nayarit; Uruapan, Michoacan; Tlopa, Guerrero; Tetela, Morelos; Tehuantepec, Dominguillo (Domingville); and Cuicatlan, Oaxaca.

Description.—Brit. Mus. Nat. Hist. 20*a*. H. grown female type; Berlin No. 577, H. grown male now M. C. Z. No. 22453, cotype of *cycluroides;* M. C. Z. No. 16070 adult male. Head elongate, flat above, covered with somewhat small hexagonal scales, and very distinctly marked off, as it were, from body; muzzle narrowed, covered with rather large smooth scales; supraoculars small, flat, and hexagonal, externals only about one-half as large as internals, and separated from each other by three rows of scales; ear opening almost as large as orbit; no dewlap; transverse gular fold present; parietal scales slightly

smaller than those on muzzle; nostrils large, very near tip of snout, almost tubular, opening obliquely backward; lores flat; 9–11 enlarged supralabials; 8–10 enlarged sublabials. Dorsal scales small, hardly more than half size of ventral scales, gradually increasing in size posteriorly, smooth; a well-developed dorsal crest composed of from 65–80 carinated scales, beginning just back of head, on neck, and continuing, uninterrupted, to sacrum; in large, old males these spines are cone-like and often reach a height of 8–15 mm. Dorsal crest and caudal crest entirely separate, there being no indication of crest in sacral region. No spines on any scales of fore or hind limbs; femoral pores vary from 4–4 to 9–9. Tail slightly constricted at insertion, rounded posteriorly, at least twice as long as body in unmutilated specimens; caudal scales above and laterally, in whorls, large, spinous; whorls separated by smaller flat scales, of which the median dorsal are spinous throughout length of tail; first and second or first, second, and third whorls of spinous scales separated by 3 rows of small flat basal scales; next 10 or 12 whorls of spinous scales separated by 2 rows of small flat scales; other whorls separated by only 1 row of flat scales, which about middle of tail, also become spinous, thereby giving distal half of tail a spiny appearance throughout. At base of tail, ventral scales much smaller, three rows corresponding to each pair above, slightly keeled and pointed posteriorly. After first 3 or 4 rows ventrals and dorsals approach each other in size, 2 rows of ventrals corresponding to a like number of dorsals. Toes rather long, especially those of hind feet; claws strong and sharp.

Measurements.—

Type	Brit. Mus. No. 20a, F type	Cotype of *Ct. cycluroides* Berlin No. 577, M now M. C. Z. No. 22453	Large adult M M. C. Z. No. 16074
	Mm.	*Mm.*	*Mm.*
Length of head	38	40	50
Length of body	130	130	165
Length of tail	289	310	430
Total length	455	480	653
Width of head over orbits	22	22	28

Coloration.—Adult: Head, neck, body, tail, and limbs dull brownish above; under parts lighter with somewhat indistinct clouds and marblings of a whitish cast. On belly and sides are three or four bands of faded slate or bluish green which extend up and across back, being hardly visible except where dorsal crest spines are involved. A few very large males exhibit blotches of rusty red or cinnamon over body, especially on sides and shoulders. Large adults of this species are often referred to as "Black Ctenosaurs."

It seems that dried skins lose most of their color, so great weight should not be given to descriptions made from such specimens.

A few color descriptions representing the observations of different students on various sized specimens, under different conditions, may be of interest, hence the following notes:

Shaw in his original description of *Ctenosaura* (*Lacerta*) *acanthura*, based upon an alcoholic specimen, which was not more than half grown, says:[3] "Upper part glaucous, variegated with a few small and somewhat indistinct clouds and marblings of a whitish cast. The tail and underparts are of a pale or yellowish color."

Harlan, who in 1824 described and figured *Ctenosaura* (*Cyclura*) *teres*[4] from a living specimen in the Museum of the Philadelphia Academy of Natural Science, gives us this description: "Color of this species dark green, on some parts of his back brilliant or glistening." Although there is no record of this specimen ever having been preserved, the description together with the splendid illustration of the specimen leaves no doubt as to its identity with *Ctenosaura acanthura*.

In writing of the color of the young of this species Wiegmann[5] says: "The color of the upper parts in this young specimen is a splendid yellowish green intermingled with bluish green and cloudy black-brown cross spots; three brown cross stripes go over the cheeks to the ear; the legs are sprinkled with numerous spots and the tail is ringed with brown. But this uncommon, beautiful coloring seems to disappear with advancing age." He also says concerning older specimen that "A somewhat larger example shows faded bluish-green, or rather a green and blue glittering gray sprinkled with numberless black dots. Upon them no traces of other marks are left visible."

Cope,[6] who described *Ctenosaura multispinis*, a synonym of *acanthura*, from a full-grown male, says: "Color above and below black." The writer examined this type of *multispinis*, which is a stuffed skin, and found it to be a true *acanthura* and that the underparts showed indistinct whitish markings, just as do most of the larger specimen.

Gunther[7] says:

> The coloration varies and changes with age. The ground color of the young is generally green, marbled with darker on the back, the dark markings forming more or less distinct, irregular cross bands, which are sometimes confluent, sometimes spotted with black, and about seven or eight in number on the back. With age the dark color becomes more diffused and irregularly distributed over the body, at places entirely suppressing the ground color, which itself assumes a more olive tinge or changes into yellowish. Specimens from Tampico are uniform black when adult, and of a greenish-olive when young.

Remarks.—Originally *Ctenosaura acanthura* was described by Shaw in 1802 from a half-grown female specimen, the date and place of collection and the name of the collector being unknown.

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[3] Shaw, George. General Zoölogy, vol. 8, part 1, p. 216, 1802.
[4] Harlan, R. Journ. Acad. Nat. Sci. Philadelphia, vol. 4. pp. 242–251, pl. 26, 1824.
[5] Wiegmann, V. J. Oken's Isis., p. 371, 1828.
[6] Cope, E. D. Proc. Amer. Philos. Soc. Phila., vol. 23, p. 267, 1886.
[7] Gunther, A. C. L. G. Biol. Cent. Amer. Rept. Batr., p. 57, 1890.

In the spring of 1824 a living specimen was brought from Tampico, Tamaulipas, Mexico, by Captain Dallas, and presented to the Academy of Natural History, Philadelphia, where it remained alive for several months. Mr. Harlan of the Academy Museum observed this lizard for several months, and in November, 1824, published a description of the specimen and notes on its habits in captivity. The plate accompanying the description makes it very clear that this species, which he called *Cyclura teres*, is in reality only an adult of *Ctenosaura acanthura*. With this evidence in hand and with records of many additional findings of this species in the Tampico district, I hereby restrict the type locality of *Ctenosaura acanthura* to Tampico, Tamaulipas, Mexico.

Wiegmann published in 1828 an account of a new species, *Ctenosaura cycluroides*,[8] based upon three specimens collected by Deppe in "Mexico," the same year, and deposited in the Zoologische Museum at Berlin, Germany. He created the genus *Ctenosaura* at this time. His specimens were kept together as cotypes, No. 577, a male, and Nos. 576 and 578, females. All were the same size and not over one-third grown. No. 577, a cotype, is now in possession of the Museum of Comparative Zoölogy (M. C. Z. No. 2253), Cambridge, Mass., received in exchange. The three specimens are certainly *Ctenosaura acanthura*. A few years after describing *Ctenosaura cycluroides*, Wiegmann, for some unknown reason, decided to redescribe these same specimens. Accordingly he gave up the genus *Ctenosaura*, that he had created in 1828, went back to the old genus *Cyclura* and redescribed them in 1834 as *Cyclura denticulata*,[9] using specimen 578 as the type. In describing *Cyclura denticulata* Wiegmann even lists *Ctenosaura cycluroides* as a synonym, but he assigns no reason for putting away the original name. Perhaps he liked the new name better. At any rate the types of both species were the same individuals, in the same containers and they bore the same accession numbers, locality labels, and collector's name, all in the handwriting of Wiegmann himself. How does the writer know these facts? Because in examining the jar containing specimen number 577 the large printed label bearing the name *Cyclura denticulata* accidently became saturated with alcohol and water and slipped down the side of the jar, thereby exposing the original label. The other jars were treated similarly and yielded like results. A check-up on the specimens, with the curator of the department in question, revealed the fact that the specimens were the same individuals, only the original accession numbers of *Ctenosaura cycluroides* being listed.

In the same publication Wiegmann described a new species, *Cyclura articulata*, giving as a synonym *Iguana* (*Ctenosaura*) *armata*, which was described by Gray in 1831,[10] and which is *Ctenosaura acanthura* of

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[8] Wiegmann, V. J. Oken's Isis., p. 371, 1828.

[9] Wiegmann, V. J. Herptologica Mexicana, pp. 43–44, 1834.

[10] Gray, (Cuvier) Griffith's Animal Kingdom, vol. 4, p. 38, 1831.

Shaw. Again he assigns no reason for changing the name of a species. Fortunately, however, neither of his last two species were ever recorded as distinct, the "law of priority," although not known as such at that time, having taken care of the situation.

In 1886 Cope published the description of *Ctenosaura multispinis*,[11] based upon an adult male dried skin from *Dondominguillo* (*Dondomingville*), Oaxaca, Mexico. A careful examination of this specimen and comparison with others indicates very conclusively that it is merely a "dark phase," or mature individual of *acanthura*. As a matter of fact the large specimens of *acanthura* are commonly known as black ctenosaurs.

Perhaps the most interesting observations made on this species are recorded by Ditmars.[12] He says:

> The old lizards are generally uniform jet black with marblings of olive or even exhibiting reddish blotches. They are surly brutes, immediately showing fight when cornered, not only endeavoring to bite, but dealing ugly blows with the generously spiked tail. From painful experience the writer (Ditmars) can testify that a blow from the spiny tail is capable of producing a severe laceration. If an avenue of escape is open, most specimens prefer flight to combat. If discovered while sunning in their favorite position, on top of a rock in a forest opening, the creature hurls himself into the shrubbery making as much noise as a frightened cow, as it goes away to a considerable distance. This species is not much in the habit of ascending trees; it can, however, climb fairly well. On the ground it is very fleet, running with the body high, the tail slightly elevated. A strong lizard can easily outrun a man as to speed, invariably escaping by darting into a thicket. Very young specimens are uniform, bright emerald green. They are persistently terrestrial, running on their hind legs in kangaroolike fashion when frightened. Observations made in large yards with a number of species of lizards, however, have demonstrated to the writer that the habit is prevalent among many of the long-bodied lacertilians of both the Agamidae and the Iguanidae. He has thus far noted the habit among 10 genera. It seems probable we have here a hereditary character, handed down from gigantic reptiles of the past, for several of those creatures, now known only by the ponderous fossils imbedded under mountains of rock, were constructed to stalk about on their powerful hind legs.

In its natural environment *acanthura* is thought of as being strictly vegetarian in its diet, but the dissection of many stomachs shows that it also is very fond of insects.

Harlan[13] observed that a specimen living in the Philadelphia Museum for several months ate nothing of its own accord, but that when raw meat or fruit was placed in its mouth, would swallow it leisurely without chewing. He showed a preference for raw meat, and always rejected cooked meat. During the summer the specimen subsisted chiefly on fruit and was never observed to drink. During the autumn (November, 1824) he became considerably torpid, remaining in one position for hours, without any disposition to move unless roused, when he displayed considerable activity. He became

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[11] Cope, E. D. Proc. Amer. Philos. Soc. Phila., vol. 23, p. 267, 1886.
[12] Ditmars, R. L. The Reptiles of the World, p. 141, 1910.
[13] Harlan, R. Journ. Acad. Nat. Sci. Philadelphia, vol. 4, pp. 242–251, 1824.

exceedingly tame, and was fond of being washed with a wet sponge. He showed no disposition to bite, but when teased or tickled on the leg defended himself with his prickly tail, with which he was able to strike in every direction.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
Brit. Mus.:						
XXII 20a	F.	Half grown	"Mexico"	Prior to 1802	(?)	Type.
	F.	Adult	Tampico, Tamaulipas, Mexico.	Nov. 13, 1889	Richardson	
	3F.	do	Tres Marias, Nayarit, Mexico.	Oct. 1, 1881	Forrer	
	2M.	do	do	do	do	
	3F.	Half grown	Tetela, Morelos, Mexico.	Sept. 30, 1903	Dr. H. Gadow	
	2M.	Adults	do	Apr. 11, 1866	Purchase	
Berlin Mus.:						
576	F.	Half grown	Mexico	1828	F. Deppe	Cotype *Cycluroides.*
577	M.	do	do	1828	do	Do.
578	F.	do	do	1828	do	Cotype *Cycluroides* and type *denticulata.*
A.M.N.H.:						
1549		do	Guerrero, Mexico	(?)	Nevins	
1552		do	Escuinapa, Sinaloa, Mexico.	(?)	J. H. Batty	
1586		do	do	(?)	do	
1595		Young	do	(?)	do	10 specimens.
U.S.N.M.:						
6403	M.	do	Mirador, Vera Cruz, Mexico.	(?)	Dr. C. Sartonius	
10234		do	Uruapax, Michoacan, Mexico.	1879	Professor Duges	
20168-72		Half grown	Tehuantepec, Oaxaca, Mexico.	Aug. 29, 1892	P. L. Jouy	
24361-2			Isabel Island, Tres Marias Island, Mexico.	Apr. 23, 1897	E. W. Nelson	
26341			Panuco River, about 80 miles above Tampico, Mexico.	(?)	W. Odell	
30430	F.	Half grown	Tehuantepec, Oaxaca, Mexico.	(?)	F. Sumichrast	
46835	F.	do	Cuicatlan, Oaxaca, Mexico.	Oct. 12, 1894	Nelson and Goldman.	
46860	F.	Young	Tlapa, Guerrero, Mexico.	Dec. 2, 1894	do	
47194	M.	do	Cuicatlan, Oaxaca, Mexico.	Oct. 9, 1894	do	
58137			Balsas, Guerrero, Mexico.	1901	J. Hurter	
58498	M.	Half grown	Tehauntepec, Oaxaca, Mexico.	1905	do	
71634	M.	do	Isabel Island, Nayarit, Mexico.	(?)	J. R. Slevin	
71635	F.	do	Tres Marias Island, Nayarit, Mexico.	(?)	do	
72737	M.	Adult	Don dominguilla, Oaxaca, Mexico.	1824	Captain Dallas	Type of *multispinis.*
M.C.Z.:						
2847	F.	Half grown	"Jalapa," Mexico	November, 1872.	E. R. Mantes	
6850	M.	Adult	Chihuahua, Mexico.			
16073		Young	Cerro del Gallo, Vera Cruz, Mexico.	1921	E. R. Dunn	
16074	M.	Adult	Cerro del Gallo	1921	do	
17481	M.	Half grown	Manuel, Tamaulipas, Mexico.	Oct. 27, 1922	W. W. Brown	
19246	F.	do	Panuco, Vera Cruz, Mexico.	Apr. 16, 1923	do	
22453	M.	do	"Mexico"	1828	F. Deppe	Formerly Berlin cotype No. 577.

CTENOSAURA HEMILOPHA (Cope)

Plate 5

Iguana acanthura Blainville, 1835, Nouv. Ann. Mus., vol. 4, p. 288, pl. 24, fig. 1.
Cyclura acanthura Duméril and Bibron, 1837, Erpétologie Générale, vol. 4, p. 22 (part).—Yarrow, 1883, Bull. 24, U. S. Nat. Mus., pp. 11, 71.—Belding, 1887, West. Amer. Scientist, vol. 3, No. 24, p. 98.
Ctenosaura species Baird, 1859, Proc. Acad. Nat. Sci. Philadelphia, p. 300.
Cyclura (*Ctenosaura*) *hemilopha* Cope, 1863, Proc. Acad. Nat. Sci. Philadelphia, p. 105–106; (Type locality, Cape St. Lucas, Lower Cal.); 1875, Bull. No. 1, U. S. Nat. Mus., pp. 50, 93.—Yarrow, 1883, Bull. 24, U. S. Nat. Mus., pp. 11, 71, 189.—Garman, 1884, Bull. Essex. Inst., vol. 16, No. 1, p. 19.—Belding, 1887, West. Amer. Scientist, vol. 3, No. 24, p. 98.
Ctenosaura hemilopha Cope, 1866, Proc. Acad. Nat. Sci. Philadelphia, p. 312.—Boulenger, 1885, Cat. Lizards Brit. Mus., vol. 2, p. 197.—Cope, 1886, Proc. Amer. Philos. Soc., vol. 23, p. 266; 1886, Proc. Acad. Nat. Sci., Philadelphia, p. 312; 1887, Bull. 32, U. S. Nat. Mus., p. 33.—Van Denburgh, 1895, Proc. California Acad. Sci., ser. 2, vol. 5, p. 88.—Mocquard, 1899, Nouv. Arch. Mus. Hist. Nat. Paris, ser. 4, vol. 1, p. 300.—Cope, 1900, Rept. U. S. Nat. Mus. for 1898, p. 238, fig. 17.—Ditmars, 1907, Reptile Book, p. 107.—Townsend, 1916, Bull. Amer. Mus. Nat. Hist., vol. 35, p. 430.—Stejneger and Barbour, 1917, Check list, N. Amer. Amph. Rept., p. 44.—Van Denburgh and Slevin, 1921, Proc. California Acad. Sci., ser. 4, vol. 11, No. 4, pp. 50, 55.—Nelson, 1921, Mem., Nat. Acad. Sci., vol. 16, No. 1, pp. 84, 114, 115, 123.—Terron, 1921, Mem. 7, Rev. Soc. Cient. Antonio Alzate, vol. 39, pp. 164, 165, 168.—Van Denburgh, 1922, Occ. Papers California Acad. Sci., No. 10, Rept. West. N. Amer., vol. 1, p. 66.—Stejneger and Barbour, 1923, Check list N. Amer. Amph. Rept., ed. 2, p. 42.
Ctenosaura acanthura Bocourt, 1874, Miss. Sci. Mex. Reptiles, p. 138.
Ctenosaura interrupta Bocourt, 1882, Le Naturaliste, vol. 2, No. 6, p. 47.
Cyclura teres Yarrow, 1883, Bull. 24, U. S. Nat. Mus., pp. 11, 71.—Belding, 1887, West. Amer. Scientist, vol. 3, No. 24, p. 98.
Ctenosaura conspicuosa Dickerson, 1919, Bull. Amer. Mus. Nat. Hist., vol. 41, Art. 10, p. 461.—Nelson, 1921, Mem. No. 1, Nat. Acad. Sci., vol. 16, p. 171.
Ctenosaura insulana Dickerson, 1919, Bull. Amer. Mus. Hist., vol. 41, Art. 10, pp. 462, 463.—Nelson, 1921, Mem. Nat. Acad. Sci., vol. 16, No. 1, pp. 114, 115, 171.

Type.—From 4 cotypes, No. 529, U.S.N.M.

Type locality.—Cape St. Lucas, Lower California, Mexico; John Xantus, collector.

Diagnosis.—Dorsal crest confined to anterior three-fourths of back, shoulder, and neck region; never continued on the posterior fourth of back. Four or five black blotches on vertebral line, separated by areas paler than the general tint. First black marking small, second broader than long and faintly continuous with the blackish brown on the ventral surface. Fifth almost confined to the median scales.

Distribution.—This species occurs in the southern two-thirds of the Lower California Peninsula, specimens having been taken at Cape St. Lucas (the type), San Jose del Cabo, Miraflores, La Paz, San

Pedro, Santa Anita, San Antonio, San Bartolo, Buena Vista, Santiago, Agua Caliente, Sierra San Lozaro, Pescadero, Trumfo, Todos Santos, and Hanson Laguna. It has also been taken on the following islands in the Gulf of California: Geralbo, San Esteban, and San Pedro Nolasco.

The questionable occurrence of this species on the mainland of Mexico is mentioned below under the remarks on the species.

Van Denburgh, who in all probability examined and studied more individuals of this species than any other worker, published in 1922[14] the most accurate account concerning it. From this paper I have quoted freely, placing in quotation marks the extracts taken therefrom. The description which follows immediately has been slightly modified according to my observations.

Description.—U.S.N.M. No. 69489–H, grown cotype; M. C. Z. No. 13179, adult male; 3178, adult male; A. M. N. H. No. 2073, adult male. Body considerably compressed. Tail conical at base, where almost square in sections. Limbs and head large, latter sharply triangular with flattened top and almost vertical sides. Nostrils large, in a round plate whose posterior edge is nearer to orbit than to end of snout. Rostral and symphyseal plates very broad and low. Ten labials. A very large plate below the eyes; a series of large superciliaries. Entire top and sides of head covered with small, irregular hexagonal plates, convex, except on snout and lores. Ear opening very large, almost vertical, and without denticulation. Several series of large sublabial plates, passing gradually into gulars. Dorsal crest begins some distance behind shielded part of head, is composed of high spines on nape, and gradually diminishes in height posteriorly. It is continued on middle third of vertebral line of body as a series of enlarged flat plates, but is not traceable on posterior third. Back and sides covered with small, smooth, subquadrate scales, which pass gradually into larger ventrals. Gular region covered with smooth scales, which become gradually larger posteriorly. Smallest gulars larger than dorsals, the largest smaller than ventrals. Scales on limbs all smooth. Tail bearing whorls of spinous scales; the first and second, and occasionally the third, of these whorls separated from each other by three series of smaller smooth scales; third, fourth, fifth, and sixth spiny whorls each preceded by two series of smooth scales, and the more distal whorls by single series which gradually become spinous. Number of femoral pores ranges from four to eight on each side. Dorsal crest higher in males than in females, but never continued on posterior part of back.

[14] Van Denburgh. Occ. Papers of California Acad. of Sci., No. 10. The Rept. of W. N. Amer., Part 1, Lizards, pp. 67–71, 1922.

Measurements.—

	M. C. Z. No. 3178 M.	A. M. N. H. No. 2073 M.
	Mm.	*Mm.*
Length of head	38	75
Length of body	115	185
Length of tail	275	420
Total length	428	680
Width of head over orbits	20	35

The following paragraphs are taken from Van Denburgh:

Coloration.—The top and sides of the head are dull pea green. The back, sides, and hind limbs are pale straw color, heavily washed with pale olive, and spotted and reticulated with seal brown and black. There are five black blotches on the vertebral line, separated by areas paler than the general tint. The first of these black markings is very small; the second is broader than long; the third and fourth are very large and faintly continuous with the blackish brown of the ventral surface; the fifth is almost confined to the enlarged medial scales. There are two longitudinal black blotches on the side of the neck and two corresponding lines on the temple. The chin, gular region, chest, and fore limbs are blackish brown. The tail has a ground color of straw yellow clouded with olive, but is dull pea green on the spines, and barred with seal brown terminally.

The youngest individuals (58 to 76 mm. from snout to vent) are bright terre-verde green above, except on the tail, which has broad rings of dark olive separated by narrow ones of broccoli brown. There are very faint indications of dark vertebral bars. The lower parts are yellowish white, tinged with green. As the animals increase in size the green gradually disappears and the dark markings increase in size and number until adult coloration is assumed.

A living specimen was colored as follows: The back and sides are grayish, mottled with black. Three transverse black bands across the shoulders. The upper surfaces of the fore limbs are black, spotted with gray; of the hind limbs, gray mottled with black. The gular region is black, bordered with gray. The ventral surface between the fore limbs is black. The belly is grayish. The tail in all specimens is ringed with alternate wide banks of brown and yellow.

Remarks.—This large lizard is very common in many parts of the cape region of Lower California, Mexico, where it lives either among rocks or trees. It ordinarily lives upon vegetable food, but it may eat crabs when its usual food is scanty. It is locally known as the iguana and is eaten by the natives. Its spiny tail is used by it as a means of defense.

Mr. J. R. Slevin,[15] of the California Academy of Science, says of this species:

It is fairly abundant where found and inhabits the large granite bowlders in company with *Uta thalassina*. Where bowlders are not plentiful these iguanas resort to trees. At San Bartolo they were seen only among the granite bowlders, which abound in that vicinity, but at San Pedro and Agua Caliente they were found in the trees; none were observed on the ground. They seem to live

[15] Occ. Papers of Calif. Acad. of Sci., No. 10, pp. 67–71, 1922.

strictly on vegetable matter, and the stomachs of the specimens collected contained the leaves of one of the common trees. On breaking off a hollow limb of a tree, at San Pedro, a specimen was found so tightly wedged within that it could be secured only by cutting it out with a small hand ax. They have the same habit as our chuckwalla (*Sauromalus ater*) of getting into crevices and holding tight by puffing up the body. Large specimens are very rare, as the natives kill them for food whenever they find one of desirable size. They are somewhat vicious when captured, and when held by the tail will always keep the mouth open ready to seize whatever comes within reach.

In *Ctenosaura hemilopha* there is great variation in the height and length of the dorsal crest and the point at which the enlarged series of scales stops on the back. Also there is great variability in the size of the large caudal scales and of the keeling on the scales of the limbs. Perhaps the greatest variation is in the color of the individuals. The black markings which serve as one of the most striking characteristics of the species vary in number, size, and shape. The ground color includes all shades between a pale yellowish gray to a dark slaty brown. Indeed, the diversity is so great as to lead one to doubt the distinctiveness of several species that have been described since *hemilopha* was first described. Blainville,[17] prior to the establishment of this species, described and figured it, calling it *Iguana acanthura*, thinking it to be Shaw's *acanthura*. For many years workers confused this species with *acanthura*. Cope, in 1863,[18] was the first to recognize the distinction and accordingly published his description, taken from four cotypes, received from Cape St. Lucas, Lower California. He placed it in the genus *Cyclura*, but later, 1866, placed it in the genus *Ctenosaura*.

In 1882 Bocourt[19] described *Ctenosaura interrupta* from specimens of *hemilopha* collected by M. Botta in Lower California. An examination of the types in Paris, and one of the cotypes in the British Museum, leaves no doubt as to their being true *hemilopha*. They agree in every respect with Cope's types, in Washington.

The species, *insulana*, based upon specimens from Ceralbo Island and *conspicuosa* from San Esteban Island, were described in 1919 by Dickerson.[20]

Concerning these species Van Denburgh says:

With good series of specimens from both these islands and from San Pedro Nolasco Island and the cape region of Lower California before me, I am unable to detect any difference in proportions or in coloration, or in the size of the spines of the caudal whorls, or the height or length of the dorsal crest, which are not fully covered by individual variation in each locality. As regards the keeling and mucronation of the scales of the legs and foot, the same is true, great individual variation in the strength of the keeling and mucronation being

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[17] Blainville, de, Nouv. Ann. Mus., vol. 4, p. 288, pl. 24, fig. 1, 1835.

[18] Cope, Proc. Acad. Nat. Sci. Philadelphia, pp. 105–106, 1863.

[19] Bocourt, Le Naturaliste, vol. 2, No. 6, p. 47, 1882.

[20] Dickerson, Bull. Amer. Mus. Nat. Hist., vol. 41, pp. 461-462, 1919.

found in all four localities. These specimens, therefore, are all referred to the one species, *Ctenosaura hemilopha*. Femoral pores in specimens from San Esteban Island vary from 5 to 8; in those from San Pedro Nolasco Island, from 6 to 9; in 10 from Ceralbo Island, from 6 to 8; in 50 from the cape region, from 4 to 7.

The writer examined the types of *Ctenosaura insulana* and *conspicuosa* and could find no characters that are not included in the normal individual variations of *hemilopha*.

Three young specimens belonging to the United States National Museum (No. 13484), collected at Guaymas, on the west coast of Sonora, and labeled "*Ctenosaura multispinis*" are *hemilopha*. Another specimen, U.S.N.M. No. 17178, also labeled "*Ctenosaura multispinis*," and said to have been collected at Nogales, Ariz., is a three-fourths grown male of *hemilopha*. Concerning the latter the United States National Museum catalogue record shows that it was "brought into town by a boy who was leading it around by a string." George B. Marsh procured the specimen from the boy, and turned it over to P. L. Jouy, who sent it to the Museum at Washington.

The three young specimens from Guaymas were in all probability reared in that vicinity, the original stock having been taken there by travelers from one of the islands of the Gulf of California or from the mainland of Lower California. The Arizona record is very doubtful.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
5295		Half grown	Sorio Rancho, Lower California, Mexico.	1859	J. Xantus	3 cotypes.
12263			Cape St. Lucas, Lower California, Mexico.	(?)	do	
12651			Miraflores, Lower California, Mexico.	1882	L. Belding	
12652			La Paz, Lower California, Mexico.	(?)	do	
12654			do	1882	do	
12655			Miraflores, Lower California, Mexico.	1882	do	
12656			La Paz, Lower California, Mexico.	1882	do	
13484	M.	Young	Guaymas, Sonora, Mexico.	1883	H. F. Emeric	3 specimens.
17178	M.	Half grown	Nogales, Ariz.	1890	P. L. Jouy and G. B. Marsh.	
21460			Lower California, Mexico.	(?)	L. Belding	
24686–93			Cape St. Lucas, Lower California, Mexico.	1859	J. Xantus	8 specimens.
24694	M.	Half grown	Santiago, Lower California, Mexico.	December, 1859	do	
37578–9			Santa Anata, Lower California, Mexico.	Jan. 15, 1906	Nelson and Goldman.	2 specimens.
37580–1			Cape St. Lucas, Lower California, Mexico.	Jan. 1, 1906	do	Do.

Material examined.—Continued.

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
37582			San Jose del Cabo, Lower California, Mexico.	Jan. 10, 1900	Nelson and Goldman.	
46885			do	Apr. 3, 1895	J. E. McLellan	
47172			do	do	do	
47958			Rio Mayo, Camoa Sonora, Mexico.	Jan. 22, 1899	E. A. Goldman	
58334-6			Lower California, Mexico.	(?)	J. Hurter	3 specimens.
64439	M.	Adult	Cerralvo Islands, Lower California, Mexico.	1911	C. H. Townsend	Type of *Ct. insulana.*
64440	M.	do	San Esteban Island, Lower California, Mexico.	1911	do	Type of *Ct. conspicuosa.*
64551-2			do	1911	do	2 specimens.
64553			Cerralvo Islands, Lower California, Mexico.	1911	do	
64554-9			Miraflores, Lower California, Mexico.	1911	do	6 specimens.
69536			Lower California, Mexico.	(?)	J. Xantus	
69489		Half grown	San Nicholas, Cape St. Lucas, Lower California, Mexico.	September, 1859	do	1 cotype.
A.M.N.H.:						
5639-41	F.	Adult	Lower California, Mexico.	1911	Albatross Expedition.	3 specimens
5657	M.	do	do	1911	do	
5658	M.	Half grown	do	1911	do	
20738	F.	do	do	1911	do	
20739	M.	Adult	do	1911	do	
M.C.Z.:						
6817	M.	Young	Miraflores, Lower California, Mexico.	1903	G. Gisen	2 specimens.
7087	M.	do	do	1903	do	
10438	M.	Adult	Cape St. Lucas, Lower California, Mexico.	1859	J. Xantus	
13178-9	M.	do	San Pedro Island, Lower California, Mexico.	1909	J. R. Slevin	Do.
15874-5	M.	do	Cerralvo Island, Lower California, Mexico.	1922	do	Do.
15878	F.	do	San Esteban Island.	1922	do	
Brit. Mus.	M.	Half grown	Lower California, Mexico.	(?)	M. Botta	Cotype of *Ct. interrupta.*
	M.	do	do	(?)	(?)	
Paris Mus.:						
2243		Adult	do	(?)	M. Botta	Do.
2245		do	do	(?)	do	Do.
2295		do	Mexico	1895	(?)	
2843		do	Lower California, Mexico.	(?)	M. Botta	Do.
96-120	M.	do	do	(?)	Diguet	
96-121	M.	do	do	(?)	do	
97-438		Half grown	do	(?)	do	

CTENOSAURA BRACHYLOPHA (Cope)

Plate 6

Ctenosaura teres brachylopha Cope, 1886, Proc. Amer. Philos. Soc., vol. 23, p. 269; 1887, Bull. 32, U. S. Nat. Mus., p. 24.

Cotypes.—Cat. Nos. 7180, 7181, 7182, 7183, U.S.N.M. Females.
Type locality.—Mazatlan, Sinaloa, Mexico, 1867; Bischoff, collector.

Diagnosis.—This species resembles somewhat *Ctenosaura pectinata* and *brevirostris*, but may be distinguished from either of them by the absence of the median dorsal crest over the sacral region. Dorsal crest made up of 65 to 75 short processes and extends only to beginning of sacral region. First, second, third, fourth, fifth (and occasionally the sixth) caudal whorls of spinous scales separated by three rows of small flat basal scales.

Distribution.—This species is found on the low coastal plains of western central Mexico. It has been collected in the States of Nayarit and Sinaloa, and it probably occurs also in Jalisco. The type specimens were collected by Bischoff near Mazatlan, in Sinaloa. Other specimens have been collected at Culiacan, Sinaloa, Tepic, San Blas, Maria Madre Island, Tres Marias Island, and Maria Cleofas Island, Nayarit.

Description.—U.S.N.M. Nos. 7180, adult female stuffed skin, 24630 adult male alcoholic specimen. Head normal in length, covered with small hexagonal scales; muzzle slightly decurved. Scales on muzzle larger than other head scales; supraocular small, being separated from each other by three or four rows of scales; nostrils large, much nearer tip of snout than to orbit, almost tubular, opening obliquely backward; rostral larger than mental; lores flat; 10 to 13 enlarged supralabials; 10 to 12 enlarged sublabials; ear opening as large or almost as large as orbit. Dorsal scales small and smooth, hardly more than half the size of ventrals, being almost granular on neck and gradually increasing in size posteriorly. Dorsal crest made up of 65–75 very short processes, which appear as merely elongated compressed scales, longer than high, except on interscapular region, where they are as high as long. Three scales on the canthus rostralis, of which the posterior is longer than deep, second deeper than long, and third, adjacent to nares is deeper than long, and divided into a superior and an inferior plate; transverse gular fold present; scales on fore and hind legs not spinous. Caudal scales above and laterally in whorls of spinous and flat scales; first seven whorls of spinous scales being separated from each other by three rows of small flat basal scales; next seven whorls by two rows of flat scales and the remainder by one row which itself finally become spinous, giving the distal third of tail a completely spinous appearance. Lower surface of tail covered with transverse series of smaller scales, strongly keeled and pointed posteriorly. Femoral pores 6–6 to 8–8.

Measurements.—	Cotype U.S.N.M. No. 7180, female.
Length of head	45 mm.
Length of body	165 mm.
Length of tail	310 mm.
Total length	520 mm.
Breadth of head over orbits	23 mm

Coloration.—Cope, in his original description, says: "The color is apparently green in life, punctuated with blackish brown. The punctulations arrange themselves into a row of median dorsal spots, and in three of the specimens into transverse bands near the middle of the sides of the abdomen. Tail with broad blackish rings."

Remarks.—This species grows to be as large as any of the Ctenosaurs, a large male specimen, from Cleofas Island, measuring over 1,000 millimeters from tip of rostrum to tip of tail. The food of this species consists largely of the leaves of trees and smaller plants.

Dr. E. W. Nelson,[21] who collected extensively in Mexico, found that this species was "rather common, living mainly in hollow trees and in brushy places." The highest elevation at which he collected the species was 500 feet.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
7180	F.	Adult	Mazatlan, Sinaloa, Mexico.	1867	Bischoff	Cotype.
7181	F.	do	do	1867	do	Do.
7182	F.	do	do	1867	do	Do.
7183	F.	do	do	1867	do	Do.
14078	F.	Young	Tres Marias Islands, Nayarit, Mexico.	(?)	A. Forrer	
24623	F.	Half grown	Maria Madre Island, Nayarit, Mexico.	May 14, 1897	Nelson and Goldman.	
24624	F.	Young	do	May 15, 1897	do	
24625	M.	do	do	do	do	
24626	F.	do	do	do	do	
24628	M.	Half grown	do	May 24, 1897	do	
24629	M.	Adult	do	do	do	
24630	M.	do	Maria Cleofas Islands, Nayarit, Mexico.	May 29, 1897	do	Very large
31286	M.	Young	(?)	(?)	Boucard	
47956	M.	Adult	Sinaloa, Mexico	Apr. 4, 1899	Nelson and Goldman.	
47957	F.	Half grown	do	do	do	
51407	F.	do	San Blas, Nayarit, Mexico.	1913	J. C. Thompson	
58752	F.	do	Tepic, Nayarit, Mexico.	October, 1897	J. Hurter	
58753	F.	Young	Sinaloa, Mexico	do	do	
60988	M.	Half grown	(?)	(?)	R. W. Shufeldt	
65138	M.	Young	Tepic, Nayarit, Mexico.	1897	Nelson and Goldman.	
70665	F.	Half grown	Culiacan, Sinaloa, Mexico.	Mar. 27, 1926	H. Meerschiedt	

CTENOSAURA PECTINATA (Wiegmann)

Plates 7, 8, 9, 10, 11

Cyclura pectinata WIEGMANN, 1834, Herpt. Mex., pl. 2, p. 42.—DUMÉRIL et BIBRON, 1837, Erpét. Gén., vol. 4, pp. 217–221.—FITZINGER, 1843, Syst. Rept., p. 56.—COPE, 1886, Proc. Acad. Nat. Sci. Philadelphia, p. 124.—BOCOURT, 1870, Miss. Scien. Mex., vol. 3, Reptiles, p. 140.—COPE, 1871, Proc. Acad. Nat. Sci. Philadelphia, p. 216.—GARMAN, 1884, Bull. Essex Institute, vol. 16, p. 19.—

[21] Nelson, E. W., Chief of the U. S. Bureau of Biological Survey, supplied his field notes on this genus.

COPE, 1885, Proc. Amer. Philos. Soc., vol. 22, pp. 379–388.

Ctenosaura pectinata GRAY, 1845, Cat. Lizards Brit. Mus., pp. 191.—SUMICHRAST, 1880, Bull. Soc. Zool. France, vol. 5, p. 174.

Ctenosaura acanthura BOULENGER, 1885, (Part) Cat. Lizards Brit. Mus., vol. 2, p. 197.—GÜNTHER, 1890, Biol. Cent. Amer., pp. 56–57, pl. 30.

Type.—Berlin Museum No. 574, male.

Type locality.—Restricted to Colima, Colima, Mexico.

Diagnosis.—This species is very near *Ct. brevirostris, similis* and *parkeri,* having in common with them the dorsal crest extending to the base of the tail, uninterrupted in the sacral region, but differing from each of them in one or more important characters. From *brevirostris* it differs in the length of the rostrum or muzzle; the rostrum of *brevirostris* being short and decurved while in *pectinata* it is elongate and not decurved in a pronounced manner. The arrangements of the caudal scales in *pectinata* and *brevirostris* are essentially the same; the first five whorls of spinous scales being separated from each other by three rows of small flat scales; the remaining whorls being separated by two rows of small scales for a short distance, then by one row which gradually becomes spinous and similar to the other caudal scales. But in *similis* only the first and second (and occasionally the third) whorls of spinous scales are separated from each other by three rows of small flat scales, the subsequent whorls of spinous scales being separated by two rows of flat scales up to about the middle of the length of the tail, then by one row of flat scales which gradually become spinous and similar to the other caudal scales just as in the other related species. In *parkeri* the first seven whorls of spinous scales are separated from each other by four rows of smaller flat scales.

Distribution.—*Ctenosaura pectinata* occurs on the west coast of Mexico from the State of Nayarit southward to Oaxaca. Collections have been made at San Blas, Maria Madre Islands, and Isabel Island, Nayarit; Colima City, and Mount Colima, Colima; Balsas and Acapulco, Guerrero; and San Geronimo, Oaxaca.

Description.—Berlin, type, No. 574, adult male; M.C.Z. 2726, adult male and female; 6982, adult female; A.M.N.H. 119, adult female. Head elongate, flat above, covered with small hexagonal scales very distinctly marked off from body. Scales on muzzle smooth and somewhat larger than other head scales; supraoculars small, flattened, and hexagonal, externals being only about one-half as large as internals and separated from each other by a row of four scales. Ear opening almost as large as orbit; no dewlap, but a pronounced transverse gular fold present; nostrils large, very near tip of snout, almost tubular, opening obliquely backward; lores flat; supralabials,

12; sublabials, 14. Dorsal scales small, hardly more than half the size of ventrals, gradually increasing in size posteriorly, smooth; a well-developed dorsal crest composed of from 63 to 75 carinated scales extending from insertion of neck caudad to base of tail, being continuous over sacral region as true carinated scales, but much reduced in height. In old males these dorsal spines reach a height of 10 mm. Leg scales without spines. Femoral pores vary from 5–5 to 7–7. Toes very long, especially those of hind feet; claws strong and sharp. Tail nearly cylindrical, scales on upper side being of two kinds, large and spinous, and small, low, flat scales arranged in whorls. Median dorsal scales are large and heavily armed throughout length of tail. The others are arranged in whorls; some whorls are spinous and some are flat and smooth. First 5 whorls of large spinous scales separated from each other by 3 rows of small flat scales; next 9 or 10 whorls of large spinous scales separated from each other by 2 rows of small flat scales, while on terminal three-fifths of tail all of scales gradually become equally spinous. At base of tail ventral scales are smaller than dorsals, four rows of ventrals corresponding to three above, slightly keeled and pointed posteriorly.

Measurements.—

	Berlin Museum, type No. 574 M.	M.C.Z.M. No. 2726	M.C.Z.F. No. 6982
	Mm.	*Mm.*	*Mm.*
Length of head	65	85	70
Length of body	205	220	210
Length of tail	[1] 405	[1] 180	455
Total length	[1] 660	[1] 485	735
Breadth of head over orbits	28	32	30

[1] Tail broken off.

Coloration.—General body color is brown-olivaceous streaked with yellow. Dorsal spines are yellow wherever the yellow markings cross the mid-back. Upper portion of head is brown, lores yellowish. Except for two small transverse brown bands the lower maxillae is yellowish. Neck brown, with rather long yellow bar running caudad from posterior margin of tympanum, vanishing slightly caudad and above axilla of arm. Abdomen yellowish olive girdled by three brown (sometimes broken) bands. Breast brown; limbs brown with yellow marks and spots. Tail ringed with alternate, wide bands of brown and yellow.

Remarks.—Wiegmann described this species from a male specimen collected by F. Deppe in "Mexico." Many specimens, ranging in age and size from very young to adults, including both sexes, have been examined and found to agree with the type in all essential characteristics.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
Berlin:						
574	M.	Adult	Mexico		F. Deppe	Type.
A.M.N.H.:						
119	F.	do	Colima, Mexico	1901	L. Diguet	
120	M.		do	1901	do	
123	M.		Mount Colima, Mexico.	1901	do	
U.S.N.M.:						
24627	F.	Young	Maria Madre Island, Nayarit, Mexico.	May 15, 1897	E. W. Nelson	
24633	F.	Half grown	Isabel Island, Nayarit, Mexico.	May, 1897	do	
47729		Young	Prextla, Puebla, Mexico.	1894	Nelson and Goldman.	
47919	M.		Rio Balsas, Guerrero, Mexico.	June 4, 1903	do	
47920	F.		do	do	do	
51402	F.	Young	Tepic, Nayarit, Mexico.	Dec. 26, 1913	J. C. Thompson	
51403	F.	do	San Blas, Nayarit, Mexico.	Dec. 20, 1913	do	
51404	M.	do	do	do	do	
51405	F.	do	do	do	do	
51406	F.	do	do	do	do	
72655-6	M.	do	Tres Marias, Nayarit, Mexico.	1885	A. Forrer	2 specimens.
72657	F.	do	do	1885	do	
M.C.Z.:						
1135-7	M. & F.	Half grown	Colima, Mexico	1914	G. Gluckert	8 specimens.
2040			Acapulco, Guerrero, Mexico.	1872	L. Agassiz	Hassler expedition.
2726	F.	Adult	do	1874	Dr. F. Heidachein.	2 specimens.
2726	M.	do	do	1874	do	Do.
6952	F.	do	San Geronimo, Oaxaca, Mexico.	1902	(?)	

CTENOSAURA BREVIROSTRIS (Cope)

Plates 12, 13, 15

Ctenosaura brevirostris Cope, 1886, Proc. Amer. Philos. Soc., vol. 23, pp. 266–268; 1887, Bull. 32, U. S. Nat. Mus., p. 34; 1900, Rep. U. S. Nat. Mus. for 1898, p. 238.

Ctenosaura acanthura Günther, 1890, Biol. Cent. Amer., Rept. Batr., p. 57, (Part).

Type.—Cat. No. 24709, U.S.N.M., male.

Type locality.—Colima, Colima, Mexico, John Xantus, collector.

Diagnosis.—This species is very similar to *Ct. pectinata*, but may be distinguished from it by the very short head with an obtuse muzzle, exhibiting a pronounced decurved profile.

Distribution.—This species occurs on the Pacific foothills of the mountain ranges from Jalisco southward to Oaxaca. The type was taken at Colima City; others have been taken at San Marcos, Jalisco; Manzanillo, Colima; Sierra Madre, Michoacan; and Guichicovi, Oaxaca. Over 90 specimens were collected at Colima by John Xantus.

Description.—U.S.N.M. Nos. 24708, adult female; 24709, half grown male cotype; 47933, adult male. The following description is from Cope's original, with modifications according to the writer's observations of the types.

Head very short with obtuse muzzle, with pronounced decurved profile. Eyes large, nostril near end of muzzle, in anterior third of distance between end of muzzle and orbit. Scales on top of muzzle and of frontal region subquadrate or subhexagonal, those of temporal regions but little longer than wide. All are more or less convex, temporals more so; rostral plate larger than mental. Six rows of scales between nasal plates, some of which are wider than long. Three canthal scales, of which the anterior is horizontally divided in one specimen. Four rows of wide loral scales above four rows of narrow scales above the supralabials. Supralabials, 11–12; sublabials, 14–15; loreals flat. Scales on muzzle larger than parietals; supraorbitals smaller than other head scales and separated from each other by four rows of scales. Dorsal scales small, hardly more than half size of ventrals, gradually increasing in size posteriorly, smooth. Dorsal crest composed of from 75 to 80 carinated scales, beginning just back of head, on neck, and continuing uninterrupted at sacrum, to base of tail. Crest over the sacrum is very low, but is present as raised carinated scales, thereby maintaining median row of raised dorsal spines or crest. In female specimens entire crest is much lower than that of male; those of adult males reaching a height of 5 to 8 mm. Limbs are without heavy spinous scales. Tail is nearly cylindrical, scales on upper side being of two kinds; large spinous scales and small, low, flat scales, arranged in whorls. Median dorsal scales are large and heavily armed throughout length of tail; others are arranged in whorls; some whorls spinous and some flat. In one specimen the first 5 whorls of large spinous scales are separated from each other by 3 rows of small, flat scales; next 9 or 10 whorls of large spinous scales by 2 rows of small, flat scales; while on the terminal three-fifths of tail all of the scales gradually become equally spinous. At base of tail ventral scales are smaller, four rows corresponding to three above, slightly keeled and pointed posteriorly. Toes very long, especially those of hind feet; claws strong and sharp.

In both specimens femoral pores are small, exceedingly so in female, which has six pores on each femur. Male has five pores on each femur. Both have distinct transverse gular fold.

Measurements.—

	Type U.S.N.M. F., No. 24708	Cotype U.S.N.M. M., No. 24709	U.S.N.M. M., No. 47933
	Mm.	*Mm.*	*Mm.*
Length of head	45	40	55
Length of body	197	150	195
Length of tail	[1] 403	420	520
Total length	[1] 645	610	775
Width of head over orbits	30	25	33

[1] Part of tail broken off.

Coloration.—General color of head and body blackish brown, being crossed on back between sacral and postscapular regions by five yellow, marks, which are bands posteriorly but become spots anteriorly. These bands are more pronounced in females. Sides of neck yellow, contrasting strongly with black of throat and nape. This yellow space is practically divided by a black line, which extends posteriorly from angle of lower jaw. Under parts are yellowish, streaked slightly with waves of blackish-brown spots; a yellow stripe beginning at posterior border of tympanum extends caudad over shoulder, fading out slightly above and caudad to axilla of arm. Limbs are blackish, and on fore arms are numerous yellow scales; digits and tail are annulated with blackish-brown and yellow rings of about equal width.

Remarks.—This species has approximately the same distribution as *Ctenosaura pectinata* and on account of the great similarity to it may be mistaken for it. Both species frequent trees, but are more often seen scurrying about on the ground and among the rocks. The chief difference between the two species is to be found in the structure of the head. In *brevirostris* the head is very short and the muzzle is pronouncedly decurved, while in *pectinata* the head is long and the muzzle only slightly decurved.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
12196		Young	Colima, Mexico	July 1, 1865	J. Xantus	2 specimens.
12230	M.	do	Sierra Madre Michoacan, Mexico.	(?)	(?)	
18968	F.	Adult	San Marcos, Jalisco, Mexico.	Mar. 26, 1892	P. L. Jouy	
18969	F.	do	do	Mar. 30, 1892	do	
24708	F.	do	Colima, Mexico	(?)	J. Xantus	Cotype.
24709	M.	Half grown	do	(?)	do	Do
24710–9		Young	do	(?)	do	10 specimens.
24720–3	M.	do	do	(?)	do	4 specimens.
24726	F.	Half grown	do	(?)	do	
31484	F.	Young	do	(?)	do	
47933	M.	Adult	Guichicovi, Oaxaca, Mexico.	June 26, 1895	Nelson and Goldman.	
58670	F.	Half grown	Colima, Mexico	July, 1902	J. Hurter	
63701	M.	Young	Manzanillo, Colima, Mexico.	February, 1863	J. Xantus	
63702–31	M. & F.	do	Colima, Mexico	(?)	do	30 specimens.
63732	M.	do	Tonala, Colima, Mexico.	(?)	do	2 specimens.
63733	M.	do	do	(?)	do	
63734–68	M. & F.	do	Colima, Mexico	July, 1863	do	35 specimens.

CTENOSAURA PARKERI, new species

Plates 14, 15

Type.—Cat. No. 18967, U.S.N.M., adult female, Barranca Ibarra, Jalisco, Mexico. April 22, 1892, P. L. Jouy.

Paratypes.—Cat. No. 18970, U.S.N.M., a half-grown female having same data; Brit. Mus. No. 1, adult male; No. 75, half-grown male;

No. 76, adult female. From Tres Marias, Nayarit, Mexico, by M. Forrer.

Diagnosis.—Dorsal crest very pronounced, not interrupted at sacrum, the continuity being effected by short lobes or depressed but enlarged scales. Tail ringed on upper half with whorls of strong and very spinous scales. First six whorls of spinous scales are separated from each other by four rows of smaller flat scales; the next three by three distinct rows and a partial fourth which borders the median dorsal spines of the tail. Subsequent whorls up to half the length of the tail are separated from each other by two rows of small scales. Distal half of tail appears spinose throughout, the smaller scales becoming larger and gradually pass into the spinous type. A comparison of this species with its most nearly related species is given under *Ct. pectinata*.

Distribution.—This species is known only from Barranca Ibarra, Jalisco, and Tres Marias, Nayarit.

Description.—U.S.N.M. Nos. 18967, adult female type; 18970, half-grown female paratype; Brit. Mus. Nat. Hist. Nos. 1, adult male; 75, adult male; 76, adult female, paratypes. Head long and narrow, covered with small hexagonal scales and very distinctly marked off from the body. Transverse gular fold present; no dewlap. Scales on muzzle larger than other head scales. Nostrils large, situated in the anterior third of the distance between orbit and tip of muzzle; nostral equal in width to mental, and deeper; lores flat, supralabials, 12; sublabials, 13. The back and sides are covered with small, smooth, subquadrate scales which pass gradually into larger ventrals. Gular region covered with small, smooth scales which become larger posteriorly. Smallest gulars as large as largest dorsals, but smaller than the ventrals. Scales on limbs without spines. Tympanum nearly as large as orbit. Supraoculars small, flat, and hexagonal, the externals being about one-half as large as the internals, the internals being separated from each other by four rows of scales. The dorsal crest begins immediately back of the head and is composed of 73 compressed lobes, being continuous with the caudal crest and not interrupted at the sacral region. The lobes are highest (7 mm.) on the nape, and gradually diminish in height posteriorly until on the sacral region, where they appear merely as enlarged keeled scales. Their size and position makes them conspicuous even in the sacral region. The dorsal crest is much higher in males than in females. The tail is ringed about on the upper half with whorls of strong and very spinous scales. These whorls of spinous scales are separated from each other by rows of smaller, flat scales, the first six by four distinct rows of small scales, the sixth, seventh, and eighth by three distinct rows and a partial

fourth row bordering on the row of median caudal spines; the subsequent whorls of spinous scales, up to half the length of the tail, are separated from each other by two rows of small scales. The distal half of the tail appears spinous throughout, the smaller scales becoming larger and gradually pass into the spinous type. The median caudal spines appear to be "set into" the other scales, so to speak; the margins of the adjacent scales lapping over the edges of the median row. The toes are very long, especially those of the hind feet; the claws are long and sharp. Femoral pores, right side 6, left side 5.

Measurements.—

	U.S.N.M. F., type No. 18967	U.S.N.M. F., paratype No. 18970
	Mm.	*Mm.*
Length of head	65	40
Length of body	225	155
Length of tail	520	330
Total length	810	525
Width of head over orbits	35	23

Coloration.—The general color of this species is olive green, lightly washed with vermilion and reticulated with brown and black. The flanks are heavily washed with vermilion. There are eight black blotches on the vertebral line, separated by areas paler than the general tint. All of the blotched markings are small and are more pronounced on the lobes making up the dorsal crest. Laterally they are represented by small blackish brown spots, but as they encircle the body they become conspicuous black bands. The transverse gular fold is heavily marked with black. There is a conspicuous black blotch bordering on the dorso-caudal margin of the tympanum. The tail is ringed with alternate wide bands of brown and yellow.

Remarks.—A half-grown female, Cat. No. 18970, U.S.N.M. (same data as above), agrees with the type in all specific characters, but varies slightly in one or two minor details. The first and second whorls of spinous scales on the tail are separated from each other by four rows of small flat scales; the second, third, and fourth by five rows; the fourth, fifth, and sixth by four rows; the sixth, seventh, and eighth by three well-defined rows and a partial fourth row; the eighth, ninth, and tenth by three distinct rows; the remainder of the tail exactly as the type. The femoral pores as 7–7. Dorsal spines 75.

Three specimens in the British Museum of Natural History, labeled from Tres Marias, Nayarit, vary slightly in the precise number and arrangement of the caudal scales, but agree with the type in all specific characters. They are designated as paratypes.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
18967	F.	Adult	Barranca Ibarra	Apr. 22, 1892	P. L. Jouy	Type.
18970	F.	Half grown	Jalisco, Mexico	do	do	Paratype.
Brit. Mus.:						
1	M.	Adult	Tres Marias, Nayarit, Mexico.		M. Forrer	Do.
75	M.	Half grown	do		do	Do.
76	F.	Adult	do		do	Do.

CTENOSAURA SIMILIS (Gray)

Plates 16, 17, 18, 19, 20

Iguana (Ctenosaura) similis GRAY, 1831, Griff. Cuv. Animal Kingdom, vol. 9, Synopsis, p. 38.

Cyclura (Ctenosaura) similis WIEGMANN, 1834, Herpet. Mex., p. 42.—FITZINGER, 1843, Syst. Rept., p. 56.

Ctenosaura completa BOCOURT, 1874, Miss. Sci. Mex., vol. 3, Reptiles, p. 145.—COPE, 1886, Proc. Amer. Philos. Soc., vol. 23, pp. 266–269.—GÜNTHER, 1890, Biol. Cent. Amer., Rept. Batr., p. 58, pl. 29.—COPE, 1900, Rept. U. S. Nat. Mus. for 1898, p. 238.—BARBOUR, 1921, Proc. New Engl. Zool. Club, vol. 7, p. 82.

Ctenosaura acanthura BOULENGER, 1885 (Part Group C), Cat. Lizards Brit. Mus., vol. 2, 197.

Type.—Museum of Mr. Bell, London, England.

Type locality.—Restricted to Tela, Honduras, Central America.

Diagnosis.—Dorsal crest very pronounced, not interrupted at sacrum, the continuity being effected by short lobes in adult male and by compressed scales in females and young. Tail ringed about on upper half with strong and very spinous scales, the first and second (and occasionally the third) of these half rings are separated from each other by three rows of small flat basal scales; subsequent whorls of spinous scales up to the first third of tail's length by two such rows of small scales; from this point the spinous scales continue without interruption to distal end of tail. Body color chrome tint, with trunk striped by five bands joining over stomach and united by numerous spots of same color. In *Ct. pectinata*, with which this species is sometimes confused, the first five whorls of spinous scales on the tail are separated from each other by three rows of small flat scales.

Distribution.—This species occupies the lowlands of Central America and southern Mexico, and the sandy beaches of Panama. In Mexico it occurs on the Isthmus of Tehuantepec and the Yucatan Peninsula. The type at the time the description was published was in the personal museum of a Mr. Bell of London, but its present whereabouts is unknown. Also the types of *Ctenosaura completa*, a synonym of *similis*, collected by Bocourt in 1872, bear no definite

locality label. They are said to have been collected in "Salvador and Guatemala." Such general records are of no real value. Consequently I hereby restrict the type locality of *similis* to Tela, Honduras, where the greater number of specimens of this species have been taken. It also has been collected at the following places: In Central America—Belize and Glovers Reef, British Honduras; Amapala, Patuca, and San Pedro Sula, Honduras; Panama City, Corozal, and San Miguel Island, Panama; Tirives, Bonilla, Oritina, and Esparta, Costa Rica; Corinto, Chinadega, Polvon, Matagalpa, and Coseguina Volcano, Gulf of Fonseca, Nicaragua; Republic of Salvador; Old Providence Island, off Nicaragua; Bocomon, Cuastotoya, and Hacienda California, Guatemala. In Mexico—Progreso, La Vega, Merida, Chichen Itza, Mujeres Island, and Cozumel Island, Yucatan; Puerto Morelos, Quintana Roo Territory; Chiapas, Tonala, Montecrista, Tabasco, Tehuantepec, Oaxaca, and Suchitepequez on the Los Patos River (14 miles from its mouth).

The specimen from Old Providence is a small female, not more than one-fourth grown. It is a true *similis* and was in all probability carried to the island from the neighboring mainland by some fishing or turtling schooner.

Description.—Paris Nos. 01–255, adult male; 2252, adult male, type. M.C.Z. No. 22624, adult female; 22088, adult male; 22625, adult male. U.S.N.M. 56782, adult male; 47565, adult female. Head long, triangular, covered with small hexagonal slightly convex scales and very distinctly marked off from the body. Muzzle narrowed; supra oculars small, being separated from each other by four or five rows of scales; ear opening is almost as large as orbit. No dewlap, but the transverse gular fold is very pronounced; parietal scales slightly smaller than those on muzzle; nostrils large, situated in anterior third of distance between orbit and tip of muzzle; rostral larger than mental; lores flat; 13–14 enlarged supralabials; 13–14 enlarged sublabials; dorsal scales much smaller than ventrals, gradually increasing posteriorly in size, and spinousness; well-developed dorsal crest composed of from 60 to 92 spinous scales, constricted and pointing slightly backward. Prominent dorsal scales begin just back of head, on neck, and continue uninterrupted to base of tail; the continuity of this crest is effected by short lobes in the sacral region of adult males and by compressed scales in females and young. Tail is ringed about on upper half with whorls of strong and very spinous scales, the first and second (and occasionally the third) of these whorls of spinous scales being separated from each other by three rows of small flat basal scales; the subsequent whorls of spinous scales up to the first third of the tail's length by two

such rows of small scales; from this point the spinous scales continue without interruption to the distal end of tail. At base of tail ventral scales are much smaller than dorsals, three rows corresponding to each pair above, slightly keeled and pointed posteriorly. After the first four or five rows, ventrals and dorsals approach each other in size, two rows of ventrals corresponding to a like number of dorsals. Toes very long, especially those of hind feet; claws long and sharp; femoral pores 5–5 to 9–9; tibia without spiny scales.

Measurements.—

	01–255, Paris, M.	2252 type, Paris, M.	22088, M.C. Z., M.	56782, U.S. N.M., M.	47565, U.S. N.M., F.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Length of head	95	70	85	100	60
Length of body	225	205	220	240	190
Length of tail	[1] 330	455	470	580	[1] 410
Total length	[1] 730	[1] 710	775	920	[1] 660
Width of head over orbits	37	31	35	38	28

[1] Tail broken off.

Paris No. 2252 is a cotype of *Ctenosaura completa* Bocourt (*Ct. similis*).

Coloration.—General body color chrome tint, trunk being striped by four or five black bands joining over stomach and united above by numerous spots of the same color. In old specimens the back bands become somewhat narrower and more or less broken up, appearing on the middorsal region of back as two distinct bands. Dorsal crest spines that lie in path of these bands are also colored black. Limbs blackish. Transverse gular fold spotted with black; throat and chin tinted with dark gray. Tail ringed with alternate wide bands of brown and yellow. In the younger specimens the general body color is light olive green, the inferior regions being yellowish, spotted with small brown or blackish dots.

Remarks.—These lizards are very common in Central America, the Peninsula of Yucatan, and the Isthmus of Tehuantepec, Mexico. They are most abundant in the lowlands on the sandy flats and beaches. Their chief food consists of tender buds. They also feed on insects, as revealed by the examination of 25 stomachs. Most of the insects were beetles and grasshoppers. In Panama the habits of this species differ slightly from those of the same species farther north. They occur on both sides of the Isthmus wherever there are sandy beaches, preferably with outcroppings of rock. They never appear about muddy shores or mangroves. These habitat associations occur more widely on the dry Pacific than on the moist Altantic side. Even in the dry Panama areas of the Pacific side one rarely sees this species more than 200 yards from the beach. They like the sand banks and rock piles

and will lie basking in the hot sunshine. When discovered they scamper away among the rocks, but never take refuge among the shrubs, bushes, or low trees as does the same species farther northward. They are common about the old sea wall at Old Panama, about the rip rap falls near La Boca, at the Pacific entrance to the canal, and at Punta Bruja, a few miles to the westward. This species is never quite as numerous in Panama as just back of the beach at Tela, Honduras, where many may be seen at almost any time. Here they may be caught by the dozens in steel traps baited with a hybiscus flower.

J. E. Gray described *Ctenosaura similis* from a dried skin belonging to a Mr. Bell of London.[22] The description, which was published in 1831, is given here "in toto":

> Allied Iguana, *Iguana (Ctenosaura) similis.*
>
> Grey, black dotted, body with four oblique dark bands; occiput forming a concave band behind; dorsal crest low but continued over the sacrum. Teeth blunt, three lobed; palatines on two raised lines on each side. Head 2 body 9 inches. Mus. Bell.

This type, a mounted skin, was formerly in the private museum of a Mr. Bell of London, but subsequently disappeared. A careful search among the specimens and records at the British Museum fail to give any clue as to its whereabouts.

Weigmann,[23] in 1834, and Fitzinger,[24] in 1843, listed this species as *Cyclura similis.* They did not see the specimen but merely adopted Gray's specific name of *similis.*

Bocourt,[25] in 1874, described this species as *Ctenosaura completa* from two adult male specimens and three young collected in "Guatemala and Salvador," by himself in 1872.

The next mention of *similis* and *completa* was by Boulenger,[26] in 1885, at which time he listed both, along with many others, as synonyms of *Ctenosaura acanthura.* From that time on *similis* has been overlooked entirely, but its synonym, *completa*, was recognized as a distinct species by Cope[27] in 1886, and since then has enjoyed that distinction, being mentioned as such as recently as 1921 by Barbour.[28]

It is indeed unfortunate that this oversight has existed for so long a time, and I take this opportunity to restore the original name of *Ctenosaura similis* to this species.

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[22] Gray, Griff. Cuv. Animal Kingdom, vol. 9, Synopsis p. 38, 1831.
[23] Weigmann, Herpt. Mex., p. 42, 1834.
[24] Fitzinger, Syst. Rept., p. 56, 1843.
[25] Bocourt, Miss. Sci. Mex., vol. 3, Reptiles, p. 145, 1874.
[26] Boulenger, Cat. Lizards Brit. Mus., vol. 2, p. 197, 1885.
[27] Cope, Proc. Amer. Philos. Soc., vol. 23, pp. 266-269, 1886.
[28] Barbour, Proc. New Eng. Zool. Club, vol. 8, p. 82, 1921.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
Brit. Mus.:						
1	M.	Adult	Colon (?) Panama	(?)	M. Bocourt	
2	M.	do	do	(?)	do	
21	M.	do	Pacific coast, Costa Rica.	1909	Ballena	
44	F.	Half grown	Mujeres Island, Mexico.	1889	S. F. Gaumer	
45	F.	do	do	1889	do	
(?)	M.	Adult	"S. Mexico"	1889	F. D. Goodman	
Paris:						
2251	M.	Young	Salvador	1872	Bocourt	Cotypes of *Ct. completa.*
2252	M.	Adult	do	1872	do	
8221	M.	do	Mexico	(?)	A. Schott	
11002	F.	do	do	(?)	(?)	
01-255	M.	do	do	1901	Dignet	
Hamburg Mus.:						
2408			Nicaragua	1895	Keasenberg	
2792			Corinto, Nicaragua.	1901	Tausen	
3546			Amapala, Honduras.	1910	Pressler	
3547			Corinto, Nicaragua.	1910	do	
3550			Nicaragua	1910	do	
4204			Corinto, Nicaragua.	1912	do	
4205			Salvador	1912	do	
A. M. N. H.:						
118	M.	Adult	Yucatan	1896	F. M. Chapman	
16398	F.	Half grown	Nicaragua	1916	Nicaragua expedition.	
16401	F.	do	do	1916	do	
Cal. A. S.:						
1097	F.	do	Cuastotoya, Jalapa, Guatemala.	(?)	(?)	
3849	F.	Young	Suchetepequez, Guatemala.	(?)	(?)	
49149	M.	Adult	Coseguina, Nicaragua.	1919	J. R. Slevin	Very large.
M. C. Z.:						
3810	F.	Young	Palvon, Nicaragua	1876	Nicheil	
5457	M. & F.	Adult and young.	do	1886	do	5 specimens.
5799	F.	Half grown	Corcuera, Nicaragua.	1886	do	3 specimens.
6270	M.	Young	Merida, Yucatan	1889	E. W. Thompson.	2 specimens.
7123	M.	do	Progreso, Yucatan	1905	L. J. Cole	
9524	F.	do	Chinadega, Nicaragua.	1905	W. B. Richardson.	
9566	F.	Adult	Metagalpa, Nicaragua.	1908	do	
10308-12	F.	Half grown	San Miguel Island, Panama.	1904	W. W. Brown	5 specimens.
10313	F.	do	Panama City, Panama.	1904	do	
15354-55	M.	Young	Orotina, Costa Rica.	1920	E. R. Dunn	2 specimens.
19274-8	F.	do	Esparta, Costa Rica.	1922	C. T. Underwood.	5 specimens.
21101-15	M. & F.	Adult and young.	Tela, Honduras	1925	Dr. H. C. Clark	15 specimens.
21743-52	M. & F.	do	do	1925	do	10 specimens.
22088	M.	Adult	Glovers Reef, British Honduras.	1925	L. L. Mowbray	Very large.
22624	F.	do	Tela, Honduras	1927	T. Barbour	
22625	M.	do	do	1927	do	
No number.	M. & F.	Adult and young.	do	1925	Dr. H. C. Clark	7 specimens.
No number.		Young	Hacienda California, Guatemala.	1926	A. W. Anthony	2 specimens.

Material examined.—Conti ued

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M. 5807			Aspinwall, Panama.		Prof. Gill	
11002			Mexico			Exchange Paris Museum.
11003	M.	Adult	"Mexico"	1872	Bocourt	Paratype *Ct. completa.*
11018	F.	Young	Nicaragua		Dr. J. A. Bransford.	
13867			Cozumel Island, Yucatan, Mexico.	Jan. 23, 1885	Albatross expedition.	
13876	F.	Half grown	West Indies, Old Providence.	1884	do	
13898	M.	Adult	Cozumel Island, Yucatan, Mexico.	Jan. 1, 1885	do	
17799–03	M.	Half grown	Honduras	1911	C. H. Townsend	6 specimens.
20290–6	M.	Young	Patuca, Honduras	1891	H. W. Perry	7 specimens.
24375–6	M.	do	San Pedro Sula, Honduras.	(?)	J. C. Ingersoll	2 specimens
24724			Yucatan, Mexico		A. Schott	
24725	M.	Half grown	do		do	
24898	M.	do	do		do	
24911	M.	Young	Belize, Honduras	(?)	(?)	
26071	M.	do	do	(?)	W. H. Stanton	
32114	F.	Half grown	"Central America."	(?)	(?)	
35723	M.	do	Bonillas, Costa Rica.	(?)	R. Ridgeway	
37002		Young	Tirives, Costa Rica.	Apr. 12, 1906	A. Alfora	
37003		do	do	do	do	
46685	F.	do	Tonalla, Chiapas, Mexico.	Aug. 9, 1895	Nelson and Goldman.	
46693	F.	do	do	do	do	
47559–62	M.	Adult	Nujeres Island, Yucatan, Mexico.	Mar. 25, 1901	do	
47563	M.	Young	do	do	do	
47564	M.	do	La Vega, Yucatan, Mexico.	Mar. 15, 1901	do	
47565	F.	Adult	Cozumel Island, Yucatan, Mexico.	Apr. 11, 1901	do	
47593	M.	Young	Palanque, Chiapas, Mexico.	May 25, 1900	do	
47647	M.	do	Puerto Morelos, Quintana Roo Territory, Mexico.	Mar. 28, 1901	do	
47793	M.	Adult	Monte Cristo, Tabasco, Mexico.	May 7, 1900	do	
47794	M.	Young	Chichen Itza, Yucatan, Mexico.	February, 1901.	do	
47802	F.	Half grown	Monte Cristo, Tabasco, Mexico.	May 7, 1900	do	
47953–5	M.	Adult	Chichen Itza, Yucatan, Mexico.	Feb. 10, 1901	do	3 specimens.
54204	M.	Half grown	Corozal, Canal Zone.	Apr. 11, 1911	Meeks and Hilderbrand.	
56780	M.	Adult	Belize, British Honduras.	May 26, 1914	J. Hurter	
56781	M.	Half grown	do	do	do	
56782	M.	Adult	Tehuantepec, Oaxaca, Mexico.	1905	do	
58499	M.	Young	do	1905	do	
58500	M.	Adult	Chinadega, Nicaragua.	1901	do	
71375–7	M. & F.	do	Bocomon, Peten, Guatamala.	(?)	Harry Malleis	Do.

CTENOSAURA BAKERI Stejneger

Plates 21, 22

Ctenosaura bakeri STEJNEGER, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 467–468.

Type.—Cat. No. 26317. U.S.N.M., male.

Type locality.—Utilla Island, Honduras, 1900; Dr. J. E. Jarnigan, collector.

Diagnosis.—A noticeable dewlap hanging from posterior part of throat; caudal whorls of spines separated by two rows and one row of flat scales. Dorsal crest high over neck and shoulders and gradually becoming shorter caudad, not continuous with caudal crest; upper sides of tibia with somewhat enlarged keeled scales; spines of median caudal crest subequal, much longer than the other caudal spines.

Distribution.—This species is confined to Utilla Island, Honduras. This island is only 7 miles long and is situated just off the north coast of Honduras, in the Caribbean Sea. It is located within the 100-fathom line of the mainland. It may occur on Bonacca and Ruatan Island also.

Description.—Cat. Nos. 26317, U.S.N.M., adult female, type; 25324, adult female paratype. Head normal in length, covered with small hexagonal scales having slightly decurved muzzle. Head scales slightly rugose in adults. Supraoculars small, being separated from each other by four rows of scales; parietal scales smaller than those on top of muzzle; nostrils large, much nearer tip of snout than orbit, almost tubular, opening obliquely backward; rostral larger than mental; lores flat; 10–12 enlarged supralabials; 9–11 enlarged sublabials; ear opening as large or almost as large as orbit; dorsal scales small and smooth, hardly more than half the size of ventral scales, being almost granular on neck and gradually increasing in size posteriorly; dorsal crest well developed over neck and shoulders, the spines gradually diminishing in size posteriorly until at sacrum they become lost, the dorsal crest not being continuous with caudal crest. Spines and scales of dorsal crest 45 to 50 in number, beginning immediately behind head, the first scale is smallest, while the crest is highest over neck and shoulders, gradually diminishing in size posteriorly, until over small of back (loins) it consists merely of a median dorsal row of enlarged and slightly carinated scales. The spines are very compressed. Maximum height of dorsal crest scales is 3.5 mm., maximum width 2.5 mm. They are falcate in shape; their base is very flexible. A fairly large compressed dewlap hangs from posterior part of throat, 10 mm. from middle of base to top, the base along middle of throat being about 30 mm.; scales on throat and dewlap smaller than ventral scales, all smooth; scales of fore limbs normal; those of hind limbs larger, some of those of femur and tibia enlarged and slightly spiniferous. Femoral pores 9–9; tail not constricted at insertion; caudal scales above and laterally in whorls of large spinous scales,

the central ones being spinous and equal or nearly so throughout length of tail; lateral spines are much less developed, being in fact smaller than median series and being separated by rows of smaller flat scales; first, second, and third whorls of spiniferous scales separated by two rows of these small flat scales; third, fourth, fifth, sixth, and seventh by one row of flat scales, and the other whorls of spiniferous scales by two rows of flat scales; caudal ventral scales smaller than dorsals, three rows corresponding to each pair above, strongly keeled and pointed posteriorly.

Measurements.—	U.S.N.M., No. 25324, adult F., paratype
Length of head	50 mm.
Length of body	160 mm.
Length of tail	265 mm.
Total length	475 mm.
Width of head over orbits	26 mm.

Coloration.—Alcoholic specimen, paratype, Cat. No. 25324, U.S.N.M. Dusky brown showing signs of green with yellow variations on neck, throat, dewlap, and abdomen; dorsal crest and back dark brown with occasional outcroppings of yellow or green.

Remarks.—This species in possessing a very noticeable dewlap shows a close relationship to *Ctenosaura palearis*, from Gualan, Guatemala, and because of this striking peculiarity needs no comparison with other species of the genus. From *palearis*, however, this species differs in the less marked differentiation of the enlarged tibial scales and in the scutellation of the tail. In *bakeri* the first, second, and third whorls of spiniferous scales are separated by two rows of smaller flat scales; the third, fourth, fifth, sixth, and seventh by one row of flat scales, and the others by two rows, while in *palearis* there is only one row of very small flat basal scales throughout. In *palearis*, the median dorsal crest consists of alternate large and small spines, while in *bakeri* the spines of the crest are equal or nearly so. In *palearis* the lateral spines on the tail are better developed than are the median series, while in *bakeri* the scales of the median series are the largest. Then, too, *bakeri* grows to be larger than *palearis*, even more so than comparative total length measurements indicate. The head and body of *bakeri* are very much heavier than that of *palearis*, but the tail is somewhat shorter.

The dewlap of *bakeri* is not as large as in *palearis*. This character, along with the peculiar scutellation of the tail in *bakeri*, tends somewhat to fill the gap between *palearis* and the other species of the genus.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
26317	F.	Adult	Utilla Island, Honduras	1898	Dr. J. E. Jarnigan	Type.
25324	F.	do	do	1898	do	Paratype.

CTENOSAURA PALEARIS Stejneger

Plates 22, 23

Ctenosaura palearis STEJNEGER, 1899, Proc. U. S. Nat. Mus., vol. 21, pp. 381–383; 1901, vol. 23, pp. 467–468.

Type.—Cat. No. 22703, U.S.N.M., male.

Type locality.—Gualan, Guatemala, 1899; Mrs. K. I. P. McElroy, collector.

Diagnosis.—A large dewlap hanging from posterior part of throat; caudal whorls of spines separated by a single row of flat scales; upper side of tibia covered with large hexagonal scales, each armed with a central spine; dorsal crest high, but composed of 35 to 45 spines only; interrupted in the sacral region.

Distribution.—This species inhabits the dry flat sandy zone of Guatemala in the vicinity of Gualan, at an elevation of from 1,000 to 2,000 feet. It has been taken at Gualan, and at Cuastotoya, Jalapa, Guatemala. These two points represent a very restricted area lying just south of the Motagua River.

Description.—The following description of the type specimen, an adult male, Cat. No. 22703, U.S.N.M., is from Doctor Stejneger's original paper.

Head rather short; muzzle with decurved profile, covered above with rather large and slightly rugose scales; supraoculars small, nearly granular externally, larger, hexagonal and flat internally, separated from each other by three rows of scales; parietal scales slightly smaller than those on top of muzzle, tubercular; nostrils large, much nearer the tip of snout than the orbit, almost tubular, opening obliquely backward; behind nostrils a large, flat scale; one or two canthal scales; lores flat; temporals slightly smaller than the occipitals, tubercular; 10 or 11 enlarged supralabials; 9 enlarged sublabials; ear opening as large as orbit; dorsal scales small, hardly more than half the size of the ventral scales, gradually increasing in size posteriorly, smooth; a well developed dorsal crest, barely indicated on the rump. The spines of the crest, 45 in number, all told, begin almost immediately behind the head; first six spines very small, followed by two somewhat larger ones; ninth is suddenly larger and tenth still larger, equaling the largest; the spines are very compressed, about 8.3 mm. (0.325 inch) high and 3.8 mm. (0.15 inch) wide at base, and falcate in shape; their base is flexible and covered for about one-fourth of their height with two to three rows of minute scales; the last 12 spines decrease gradually in size, the last being equal to the first ones on the nape; about 10 small carinated scales follow until the caudal crest begins; three transverse dermal folds across the throat which, with a similar one behind the ear, join two longitudinal folds on the side of the neck; these extend backward over the shoulder for some distance; between the anterior and posterior transverse gular folds a large compressed dewlap 32 mm. (1¼ inches) from middle of base to top, the base along the middle of the throat being about 38 mm. (1½ inches); scales on throat and dewlap slightly smaller than the ventral scales, all smooth; scales on upper side of arm carinate, those on lower arm slightly larger, more distinctly carinate and somewhat spinous at tip; scales on femur slightly larger than ventral scales, those on the upper surface obtusely keeled and with a small pointed tubercle at tip; scales on upper middle portion of tibia greatly enlarged, more or less regularly hexagonal, each with a falcate

spine near center; scales on upper side of hind feet toward toes enlarged, keeled, and spinous; 7 large femoral pores on each side; tail somewhat constricted at insertion, much depressed at base, becoming subcylindrical posteriorly; caudal scales above and laterally in whorls of large spinous scales, separated by a single row of smaller flat scales, the central one being spinous, however; in the spinous row the median scales are the shortest, the lateral one the longest, while in the smaller and smooth row the proportion is reversed, so that the anterior outline of the large row is concave and the posterior outline of the small row is convex; the outlines of each pair or rows perfectly straight; in the spinous row the scale on each side of the central one is without a spine; the lateral spines are straight; the central falcate, the median spines form a caudal crest, in the basal half of which the spines alternate large and small, according to whether they belong to the large or small row; caudal scales below much smaller, three rows corresponding to each pair above, strongly keeled and pointed posteriorly.

Adult female: Same as male except that the dewlap is smaller and the dorsal crest is made up of shorter spines.

Measurements.—	U.S.N.M. No. 22703, adult, male
Length of head	40 mm.
Length of body	140 mm.
Length of tail	230 mm.
Total length	410 mm.
Width of head over orbits	23 mm.

Coloration.—Green with yellow variegations on throat, dewlap, and lateral folds; dorsal crest pale yellowish; on body several ill-defined, chevron-shaped blackish bands, which do not cross the dorsal crest, but the posterior three of which reach the abdomen; tail marked with broad bands of dull blackish brown.

Remarks.—Doctor Stejneger says:

Another specimen (No. 22704, U.S.N.M.) of the same age and sex, which differs in no essential feature from the one described, except that the dorsal crest contains 36 spines only, and that the interruption between the doral and caudal crests is complete, being not even indicated by a row of carinated scales. Another peculiarity is that one of the small scales at the base in front of each dorsal spine has developed into a very minute spine. A third specimen (No. 24459, U.S.N.M.) is very young, only 198 mm. (7.8 inches) long. The dewlap is already well indicated, being 5 mm. (0.2 inch) deep; all the other diagnostic characteristics are also present and well marked. The dorsal crest is quite pronounced, the spine being triangular, about as high as long; the large ones standing some distance apart, the interval being wider than the basis of the spines; the small ones as the anterior and posterior ends are placed quite close; the number of the spines is 37; the crest perfectly interrupted on the rump. Eight femoral pores. Color essentially as in adults.

The material from which the type was described was received at the United States National Museum in 1899 from Mrs. K. I. P. McElroy of Gualan, Guatemala.

In May, 1926, Doctor MacPhail, of the United Fruit Co. Hospital at Quirigua, forwarded to Dr. Thomas Barbour, at the Museum of Comparative Zoölogy, 12 very fine specimens. They also were taken

at Gualan, Guatemala, and agree with the type specimen in every essential characteristic and have been designated as topotypes. This is a remarkable series of a very rare species, nine males and three females.

Two specimens belonging to the California Academy of Science were examined and they also agree perfectly with the type. They were collected at Cuastatoya, Jalapa, Guatemala.

In Doctor Stejneger's original paper on this species he emphasized its close affinity to the other members of the genus, and stated that the presence of the dewlap was not sufficient ground upon which to erect a new genus. His discovery of *Ctenosaura bakeri* three years later, 1901, has bridged the gap between *palearis* and the other species of the genus and also demonstrated the wisdom of not creating a new genus based upon the dewlap character.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
U.S.N.M.:						
22703	M.	Adult	Gualan, Guatemala.	1899	Mrs. K. I. P. McElroy.	Type.
22704	F.	do	do	1899	do	
24459	M.	do	do	1899	do	
48965	F.	do	Guatemala		Prof. Newton Miller.	
C.A.S.:						
857	M.	Young	Cuastatoya, Guatemala.	(?)	(?)	
1098	M.	Adult	Guatemala	(?)	(?)	
M.C.Z.:						
22392	F.	do	Gualan, Guatemala.	1926	Doctor MacPhail.	Topotype.
22394	F.	do	do	1926	do	Do.
22398	F.	do	do	1926	do	Do.
22393	M.	do	do	1926	do	Do.
22395	M.	do	do	1926	do	Do.
22396	M.	do	do	1926	do	Do.
22397	M.	do	do	1926	do	Do.
22399	M.	do	do	1926	do	Do.
No number	3M.	do	do	1926	do	Do.

CTENOSAURA QUINQUECARINATA (Gray)

Plates 24, 25, 26

Cyclura quinquecarinata Gray, 1842, Zool. Misc., p. 59.—Sumichrast, 1873, Arch. Sci. Phys. Nat., vol. 46, p. 259.

Enyoliosarus quinquecarinata Gray, 1845, Cat. Lizards Brit. Mus., p. 192.

Cyclura (*Ctenosaura*) *quinquecarinata* Cope, 1869, Proc. Amer. Philos. Soc., vol. 11, p. 161.

Ctenosaura (*Enyaliosaurus*) *quinquecarinata* Bocourt, 1874, Miss. Sci. Mex., vol. 3, Reptiles, p. 138; 1876, Journ. Zool., vol. 5, p. 401.

Ctenosura quinquecarinata Sumichrast, 1880, Bull. Soc. Zool., vol. 10, p. 175.—Bocourt, 1882, Le Nat., vol. 2, No. 6, p. 47.—Boulenger, 1885, Cat. Lizards Brit. Mus., vol. 2, p. 198.—Cope, 1886, Proc. Philos. Soc. Amer., vol. 23, pp. 266–269.—Günther, 1890, Biol. Centr. Amer., Rep. and Batr., p. 58.—Dugès, 1897, La Naturleza, ser. 2, vol. 2, No. 12, p. 523, pl. 34.—Cope, 1900, Rept. U. S. Nat. Mus. for 1898, p. 238.—Stejneger, 1899, Proc. U. S. Nat. Mus., p. 383.

Type.—Brit. Mus. Nat. Hist. No. 61, male. Collected March 5, 1841, no locality.

Type locality.—Restricted to Tehuantepec, Oaxaca, Mexico.

Diagnosis.—Median dorsal crest made up of low, thin, leaflike scales, extending from nape to sacrum. Upper surface of hind limbs covered with large spinous scales. Upper surface of tail covered with alternate rings of larger and smaller scales, the central, and especially the two or three lateral series of larger scales, being very large and heavily armed with a sharp spine directed backward. Except at base of tail the larger scales forming the three series on either side of the central caudal spines are flat.

Distribution.—The type specimen of *quinquecarinata* is a stuffed skin, in the British Museum of Natural History. It is without any locality or collector's label. Of the 23 specimens examined, 19 are designated as being from Tehuantepec, Oaxaca, Mexico; 2 are labeled merely "Mexico"; 1 is listed from Oaxaca, Mexico. In all probability all of the specimens came from Tehuantepec, at which place the elevation ranges from 100 to 600 feet above sea level. This species is perhaps confined to the Isthmus of Tehuantepec, and upon the evidence presented above I hereby restrict the type locality of *Ctenosaura quinquecarinata* to Tehuantepec, Oaxaca, Mexico.

Description.—Brit. Mus. Nat. Hist. Nos. 61, adult male, type, stuffed skin; 33, adult male, alcoholic specimen; U.S.N.M. Nos. 30127, female; 30561, male; 30562, male; 30563, male. Head normal in length, covered with small hexagonal scales, with slightly decurved muzzle. Supraoculars very small, being separated from each other by three rows of scales; nostrils large, on canthus rostralis, lateral; loreal region smooth. Supralabials, 8; sublabials, 10; rostral wider than mental; ear opening as large as orbit; strong transverse gular fold; dorsal scales small and smooth, being almost granular on neck and gradually increasing in size posteriorly until over small of the back. On the rump they become a little larger than ventrals, rhomboidal and obtusely keeled. Outer side of tibia armed with large spinous scales. Dorso-nuchal crest made up of 50 to 60 thin, leaflike scales ranging from 1 to 5 mm. in height, and extending from nape to small of back (loins), or to sacrum, but never continuous over sacrum; more pronounced in males than in females. Tail longer than head and body together, slightly constricted at insertion; depressed in its anterior third, but cylindrical posteriorly; its upper surface covered with alternate whorls of larger and smaller scales; the central, and especially the two (occasionally three) lateral series of the former, very large and spinous; the latter and the three (occasionally four) larger series adjacent to the central spinous row flat. First two or three whorls of large scales at base of tail are all spinous. Lower surface of tail covered with transverse series of smaller scales, strongly keeled and pointed posteriorly. Femoral pores vary from 5–5 to 7–7.

Measurements.—

	U.S.N.M., No. 30561, adult male
Length of head	35 mm.
Length of body	95 mm.
Length of tail	200 mm.
Total length	330 mm.
Width of head over orbits	20 mm.

Coloration.—Above and on sides pea green, mottled with black or brown; legs also pea green with prominent black splotches, in some instances taking the form of more or less indistinct transverse cross-bands; lower surfaces yellowish, uniform or spotted with brown; throat grayish, mottled; chin dark. The young are green throughout, being somewhat lighter on the under parts.

Remarks.—This species is very closely related to *clarki*, *erythromelas*, and *defensor*, and a comparison of it with these species is given under the remarks on *erythromelas*.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
Brit. Mus.:						
2	F.	Adult	Oaxaca, Mexico	Nov. 11, 1841	Purchased from Bocourt collection.	
29	M.	do	do	Sept. 30, 1903	H. Gadow	5 specimens.
33	M.	do	Tehuantepec city, Oaxaca, Mexico.	Oct. 10, 1890	A. C. Butler	
61	M.	do	(?)	March, 1841	(?)	Type.
(?)		do	Oaxaca, Mexico	(?)	(?)	Stuffed skin.
Paris Mus.:						
1322	M. & F.	do	do	(?)	F. Sumichrast	2 specimens.
5916	M. & F.	do	do	(?)	do	Do.
Hamburg Mus.:						
661	M.	do	"Mexico"	1878	Fischer	
662	F.	do	do	1878	do	Do.
735	M.	do	(?)	1879	Schilling	
1208			Hugma, Terminos	1891	Peaersen	
1717			"Mexico"	1894	Nepperschnids	
3200			(?)	1904	Poppinhausen	
U.S.N.M.:						
30127	F.	Adult	Tehuantepec, Oaxaca	(?)	F. Sumichrast	A good series of the species.
30561	M.	do	do	(?)	do	
30562	M.	do	do	(?)	do	
30563	M.	do	do	(?)	do	
30564	M.	do	do	(?)	do	
30565	F.	do	do	(?)	do	
30566	M.	do	do	(?)	do	
30567	M.	do	do	(?)	do	

CTENOSAURA CLARKI, new species

Plate 27

Type.—M.C.Z. No. 22454, male, paratype. U.S.N.M. No. 21499, female.

Type locality.—Ovopeo, Michoacan, Mexico.

Diagnosis.—Dorsal crest indicated by 80 slightly raised scales. Tail shorter or equal to length of head and body, its upper surface with whorls of very large subequal spines, directed upward and

backward, alternating with series of smaller yet conspicuous basal flat scales.

Distribution.—Of the six specimens of this species known to be in museum collections, only one bears a locality label. This one specimen, M.C.Z. 22454, an adult male, was taken at Ovopeo, Michoacan, Mexico, at an elevation of 1,000 feet, January, 1908, by Dr. H. Gadow, and was received by the M.C.Z. from the British Museum of Natural History in 1926 in exchange. This being the only record for this species I hereby restrict the type locality of *Ctenosaura clarki* to Ovopeo, Michoacan, Mexico.

Description.—M.C.Z. No. 22454, adult male, type; U.S.N.M. No. 21499, adult female, paratype. Head normal in length, covered with medium-sized scales, which are slightly rugose and convex. Muzzle slightly decurved, loreal region slightly concave; supra oculars small, being separated from each other by three rows of scales; parietals smaller than those on top of muzzle; nostrils large, on canthus rostralis; supralabials 1; sublabials 1; rostral and mental of equal width; ear opening as large or almost as large as orbit; transverse gular fold prominent; dorsal scales small on nape, becoming larger posteriorly until about the mid-region of the back where they are larger than the ventrals, being rhomboidal in shape, obtusely keeled and slightly carinated, more so in the sacral region. Lateral scales smaller than either dorsals or ventrals. Upper surface of hind limbs with medium-sized spinous scales. Tail slightly shorter than head and body, slightly constricted at insertion, and somewhat depressed, except near distal end, where it is cylindrical; its upper surface with whorls of large subequal spines, directed upward and backward, alternating with series of smaller flat scales which are very conspicuous from the beginning; the two larger series of spinous scales adjacent to the central spinous row smaller than lateral series; lower surface of tail with smaller pointed keeled scales, the number of transverse series not being the same as on the upper surface except on the distal half of the organ. Dorsal crest made up of slightly raised scales beginning just back of head and continuing about two-thirds of the way down the back, gradually merging with the general dorsal scales. Digits shortened. Femoral pores 5–4.

Measurements.—	M.C.Z. type, No. 22454, male
Length of head	33 mm.
Length of body	110 mm.
Length of tail	132 mm.
Total length	275 mm.
Width of head over orbits	20 mm.

Remarks.—In the females the spinous scales of the tail do not show up as conspicuously as in the males, the two series adjacent to the

central spinous row often appearing as only slightly carinated scales. The conspicuousness of the intervening whorls of flat scales will readily separate it from its near relatives: *erythromelas*, and *defensor;* the short dorsal crest spines separate it from *quin quecarinata.*

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
M.C.Z.:						
22454	M.	Adult	Ovopeo, Michoacan, Mexico.	January, 1908	Dr. H. Gadow	Type.
U.S.N.M.:						
21499	F.	do	"Mexico"	(?)	(?)	Paratype.
21450	M.	do	do	(?)	(?)	
21451	M.	do	do	(?)	(?)	
21452	M.	do	do	(?)	(?)	
21453	F.	do	do	(?)	(?)	

CTENOSAURA ERYTHROMELAS Boulenger

Plates 28, 29

Ctenosaura erythromelas Boulenger, 1886, Proc. Zool. Soc. London, p. 241, pl 23.—Günther, 1890, Biol. Cent. Amer., Rept. and Batr., p. 59.

Cachryx erythromelas Cope, 1887, Bull. 32, U. S. Nat. Mus., p. 43.

Ctenosaura (*Cachryx*) *annectens* Werner, 1911, Jahrbuch Hamburg. Wissensch.. Anst., Pt. 2, p. 25.

Type.—Brit. Mus. Nat. Hist. No. 1, male.

Type locality.—"Mexico." No exact locality known.

Diagnosis.—A slight indication of a dorso-nuchal crest. Scales on posterior part of back a little larger than ventrals, rhomboidal, indistinctly keeled. Upper surface of hind limbs with medium-sized spinous scales. Tail shorter than head and body, its upper surface with whorls of very large subequal spines, directed upward and backward, alternating with series of very small flat basal scales, the series of small flat scales hardly noticeable at first glance, but becoming more conspicuous posteriorly until near the mid-tail, where they are very conspicuous.

Distribution.—No exact locality is known for this species. The type was purchased alive in Liverpool, England. The dealer did not know whence it came. In 1905 Pohl sent several zoological specimens from "Mexico" to the Naturhistorischen Museums in Hamburg. Among the number was a specimen of this species, hence the type locality "Mexico."

Description.—Brit. Mus. Nat. Hist. No. 1, male, type. Head normal in length, covered with medium-sized scales, which in the adults are slightly rugose and convex. Muzzle only slightly decurved; loreal region slightly concave; supraoculars small, being separated from each other by three rows of scales; parietal scales smaller than those on top of muzzle; nostrils large, on canthus rostralis; supralabials, 8; sublabials, 9; rostral and mental of equal width; ear opening as large

or almost as large as orbit; transverse gular fold prominent; dorsal scales almost granular on nape, becoming larger posteriorly until about the mid-region of the back, where they are larger than the ventrals, being rhomboidal in shape, obtusely keeled, and slightly carinated, more so in the sacral region. Lateral scales smaller than either dorsals or ventrals. Upper surface of hind limbs with medium-sized spinous scales. Tail shorter than head and body, slightly constricted at insertion, and somewhat depressed, except near distal, where it is cylindrical; its upper surface with whorls of very large subequal spines, directed upward and backward, alternating with series of small, flat scales, inconspicuous at first glance, but becoming more conspicuous posteriorly until near the mid-tail, where they become very conspicuous; lower surface of tail with smaller, pointed, keeled scales, the number of transverse series not being the same as on the upper surface except on the distal half of the organ. Dorsal nuchal crest, beginning just back of the head on the nape, is indicated by 35 to 60 slightly raised median dorsal scales, which extend usually about one-third of the way down the back and then gradually merge with the general dorsal scales. In no instance does the dorsal crest extend completely to the sacrum. Digits shortened. With hind limb extended the longest digit reaches to the anterior insertion of the fore limb; femoral pores, 5–5, 6–6, to 8–8.

Measurements.—

	Hamburg, No. 3420, M.	Brit. Mus., type No. 1, M.
	Mm.	*Mm.*
Length of head	35	24
Length of body	120	66
Length of tail	150	88
Total length	285	178
Width of head over orbits	25	(?)

Coloration.—Boulenger in his original description figures this species in colors and gave the following description taken from a living specimen, the type.

Blackish olive above, with a large patch of vermilion-red on each side of the body, and variegations of the same color on the sides of the head and neck; lower surfaces grey; throat marbled with red; three oblique black bands on each side behind the fore limb; two black bands across the humerus. Tympanum yellowish. Iris golden.

Werner's type specimen of *Ctenosaura* (*Cachryx*) *annectens*, an adult male in the museum in Hamburg, Germany, although preserved in alcohol for several years[29] and without its epidermis, exhibits a distinct reddish tinge about the head, neck, and shoulders.

[29] Described in 1911, but probably in alcohol many years previous.

Remarks.—This species along with *clarki* bridges the gap between *quinquecarinata* and *defensor* and justifies the union of the two genera as suggested by Boulenger.[30] The chief differences between *quinquecarinata, clarki, erythromelas,* and *defensor* are to be found in the characters of the tail. In *clarki* and *erythromelas* the tail, like that of *defensor,* is shorter than the head and body, one character that sets the three species off from *quinquecarinata,* whose tail is longer than the head and body. The main distinguishing characters, however, have to do with the arrangement of the spinous scales on the tail. In *defensor* the entire upper surface of the tail is covered with whorls of strong erect conic spinous scales which are not separated by rows of smaller flat scales; in *erythromelas* the upper surface of the tail is covered with whorls of very long subequal spines, alternating with a series of small flat basal scales, hardly visible at first glance, but becoming more conspicuous posteriorly until near the middle of the tail, where they become very conspicuous; in *clarki* the whorls of spines alternate with whorls of smaller flat scales which are very conspicuous from the base of the tail to its tip, while in *quinquecarinata* the tail is covered with alternate whorls of large and smaller scales, the central, and especially the two (occasionally three) lateral series of the former, very large and spinous; the latter and the three (occasionally four) larger series adjacent to the central spinous row flat, except the first two or three whorls of large scales at the base, which are all spinous.

Werner described *Ctenosaura* (*Cachryx*) *annectens* from a specimen of *erythromelas.* Although the specimen is damaged, it agrees in every particular with the true *erythromelas,* to which it must be assigned. This specimen was collected in 1905 by Phol, but its locality, as I have said, is unknown.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
Brit. Mus. No. 1	M.	Adult	(?)	(?)	Purchased alive	Described.
Hamburg 3420	M.	do	"Mexico"	1905	P. Phol	Type *annectens.*

CTENOSAURA DEFENSOR (Cope)

Plate 30

Cachryx defensor COPE, 1866, Proc. Acad. Nat. Sci. Philadelphia, vol. 18, p. 124; 1869, Proc. Amer. Philos. Soc., p. 169, pl. 10.—BOCOURT, 1870, Miss. Sci. Mex., vol. 3, Reptiles, p. 148, pl. 17, fig. 12, 12*a*.—BOULENGER, 1885, Cat. Lizards Brit. Mus., vol. 2, p. 198.—COPE, 1887, Bull. 32, U. S. Nat. Mus., p. 34.—DUGÈS, 1897, Soc. Mex. Hist. Nat., ser. 2, vol. 2, No. 12, p. 524.—BERG, 1902, Zool. Garten, vol. 43, No. 3, p. 86–92.

Ctenosaura defensor GÜNTHER, 1890, Biol. Cent. Amer., Rep. Batr., p. 58.

[30] Boulenger, Proc. Zoöl. Soc. London, p. 241, 1886.

Type.—Three cotypes, U.S.N.M., male No. 12282, Yucatan. A. Schott, collector.

Type locality.—Restricted to Chichén Itzá, Yucatan, Mexico.

Diagnosis.—Tail short, almost flat, covered with whorls of strong, erect, conic spinous scales, which are not separated by rows of small flat scales. Scales on femur and tibia are spiniferous and larger than those of the fore limbs. Dorsal crest barely noticeable, being made up of slightly carinated scales, and extending from the nape to the beginning of the sacrum. Scales on the rump larger than those on body. Digits shortened.

Distribution.—This lizard is known only from Yucatan, Mexico. It is a ground-dwelling species and is most abundant on the desert and semiarid limestone plains of the peninsular, having been taken at Chichén Itzá.

Description.—M.C.Z. No. 7095, adult female. Head normal in length, covered with fairly large scales, having slightly decurved muzzle. Scales of head somewhat convex, those on muzzle being larger than others; supraoculars smaller than parietals, separated from each other by three rows of scales; nostril on canthus rostralis, lateral; loreal region concave. Supralabials 7; sublabials 7; ear opening as large as orbit, without marginal serrations. Scales of body small, slightly imbricate, homogeneous, smooth, in transverse series, and obliquely longitudinal, larger on rump, smaller on the sides; a slightly larger vertebral series forming a barely noticeable dorsal crest which extends from the nape to the beginning of the sacrum. Abdominals smooth and equal; gulars a little smaller, equal on plica. A prebranchial and postbranchial fold. Scales of fore limbs moderate, some of those on femur and tibia much larger, spiniferous. Tail short, flat, and covered with 15–25 whorls of strong, erect, conic, spinous scales, which are not separated by smaller flat scales. The scales below are margined and keeled, the carina being prolonged into a flat spine. Spiniferous superior whorls made up of seven longitudinal series; the spines being erect, those of the median row smaller. With hind limbs extended the longest digit does not reach the axilla. Femoral pores 6–6 to 11–11.

Measurements.—	M.C.Z. No. 7095, adult, male
Length of head	32 mm.
Length of body	90 mm.
Length of tail	100 mm.
Total length	222 mm.
Width of head over orbits	17 mm.

Coloration.—General color, bright olivaceous. Shoulders and interscapular region almost black; the latter with two cross series of green spots, more or less distinct on the whole body in young specimens.

In older specimens the median dorsal region is bright rufous. Underparts light.

Remarks.—This species is decidedly iguaniform, but the digits are too short for an arboreal habit. A comparison of this species with its nearest relatives, *erythromelas*, *clarki*, and *quinquecarinata*, is given under the discussion of the former.

Material examined.—

Specimen	Sex	Age	Locality	Date	Collector	Remarks
M. C. Z. No. 7095.	F.	Adult	Chichén Itzá, Yucatan, Mexico.	(?)	L. J. Cole	Described.
Brit. Mus. No. 1.		do	(?)	Sept. 21, 1900	(?)	
U. S. N. M. 12282.	M.	Adult and half grown.	Yucatan, Mexico		A. Schott	3 cotypes.

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EXPLANATION OF PLATES

PLATE 1

Ctenosaura acanthura (Shaw). Head and body of half-grown female, Brit. Mus. Nat. Hist. No. XXII 20*a*-type

PLATE 2

Ctenosaura acanthura (Shaw). Sacral region and tail of half-grown female, Brit. Mus. No. XXII 20*a*-type

PLATE 3

Ctenosaura acanthura (Shaw). Cotype of *C. cycluroides* Wiegmann, Zoologisches Museum, Berlin No. 577 which is now M.C.Z. No. 22453, a half-grown male

PLATE 4

Ctenosaura acanthura (Shaw). Adult male M.C.Z. No. 16074

PLATE 5

Ctenosaura hemilopha (Cope). Adult male M.C.Z. No. 13179

PLATE 6

Ctenosaura brachylopha (Cope). Adult female stuffed skin. Cotype U.S.N.M. No. 7180

PLATE 7

Ctenosaura pectinata (Wiegmann). Type of *Cyclura* (*Ctenosaura*) *pectinata*, Zoologisches Museum, Berlin No. 574, adult male, head and body

PLATE 8

Ctenosaura pectinata (Wiegmann). Type of *Cyclura* (*Ctenosaura*) *pectinata*, Zoologisches Museum, Berlin No. 574, adult male, sacral region and tail

PLATE 9

Ctenosaura pectinata (Wiegmann). Adult male M.C.Z. No. 2726

PLATE 10

Ctenosaura pectinata (Wiegmann). Adult female, Amer. Mus. Nat. Hist., No. 119

PLATE 11

Upper. *Ctenosaura pectinata* (Wiegmann), showing small size of femoral pores of female as compared to those of the male below. ⅔ natural size. M.C.Z. Lot No. 2726

Lower. *Ctenosaura pectinata* (Wiegmann), showing the size of the femoral pores of the adult male. ⅔ natural size. M.C.Z. Lot No. 2726

PLATE 12

Ctenosaura brevirostris Cope. Head, body, and sacral region of adult male. U.S.N.M. No. 47933

PLATE 13

Ctenosaura brevirostris Cope. Half-grown male. Cotype, U.S.N.M. No. 24709

PLATE 14

Ctenosaura parkeri Bailey. Adult female. Type, U.S.N.M. No. 18967

PLATE 15

Heads of *Ctenosaura parkeri* Bailey (left), U.S.N.M. No. 18967, and *C. brevirostris* Cope (right), U.S.N.M. No. 47933. Compare the length of the heads. Both are adults

PLATE 16

Ctenosaura similis (Gray). Cotype of *Ctenosaura completa* Bocourt, Muséum d'Histoire Naturelle de Paris, No. 2252. Adult male

PLATE 17

Ctenosaura similis (Gray). Half-grown male, M.C.Z. No. 21102, and young male, M.C.Z. No. 22669. Note the stripes on both

PLATE 18

Ctenosaura similis (Gray). Adult female taken in March, 1927. Oviducts filled with mature eggs. M.C.Z. No. 22624

PLATE 19

Ctenosaura similis (Gray). Adult male, M.C.Z. No. 22625

PLATE 20

Upper. Typical habitat of *Ctenosaura similis* (Gray). Punta, Paitilla, near Panama City, Panama

Lower. Typical habitat of *Ctenosaura similis* (Gray). Punta, Paitilla, near Panama City, Panama

PLATE 21

Ctenosaura bakeri Stejneger. Adult female. Paratype, U.S.N.M. No. 25324

PLATE 22

Showing the dewlap of *Ctenosaura:* (*a*) *bakeri*, female, paratype, U.S.N.M. No. 25324; (*b*) *palearis*, male, topotype, M.C.Z. No. 22395; (*c*) *palearis*, female, topotype, M.C.Z. No. 22392

PLATE 23

Ctenosaura palearis Stejneger (left), female, M.C.Z. No. 22392; (right) male, M.C.Z No. 22395. Adults. Topotypes

PLATE 24

Ctenosaura quinquecarinata (Gray). Sacral region and tail of type, Brit. Mus. Nat Hist. No. 61. Dried skin, adult male

PLATE 25

Ctenosaura quinquecarinata (Gray). Sacral region and tail of alcoholic specimen, Brit. Mus. Nat. Hist. No. 33, adult male

PLATE 26

Ctenosaura quinquecarinata (Gray). U.S.N.M. No. 30561. Adult male

PLATE 27

Ctenosaura clarki Bailey. Type, M.C.Z. No. 22454. Adult male

PLATE 28

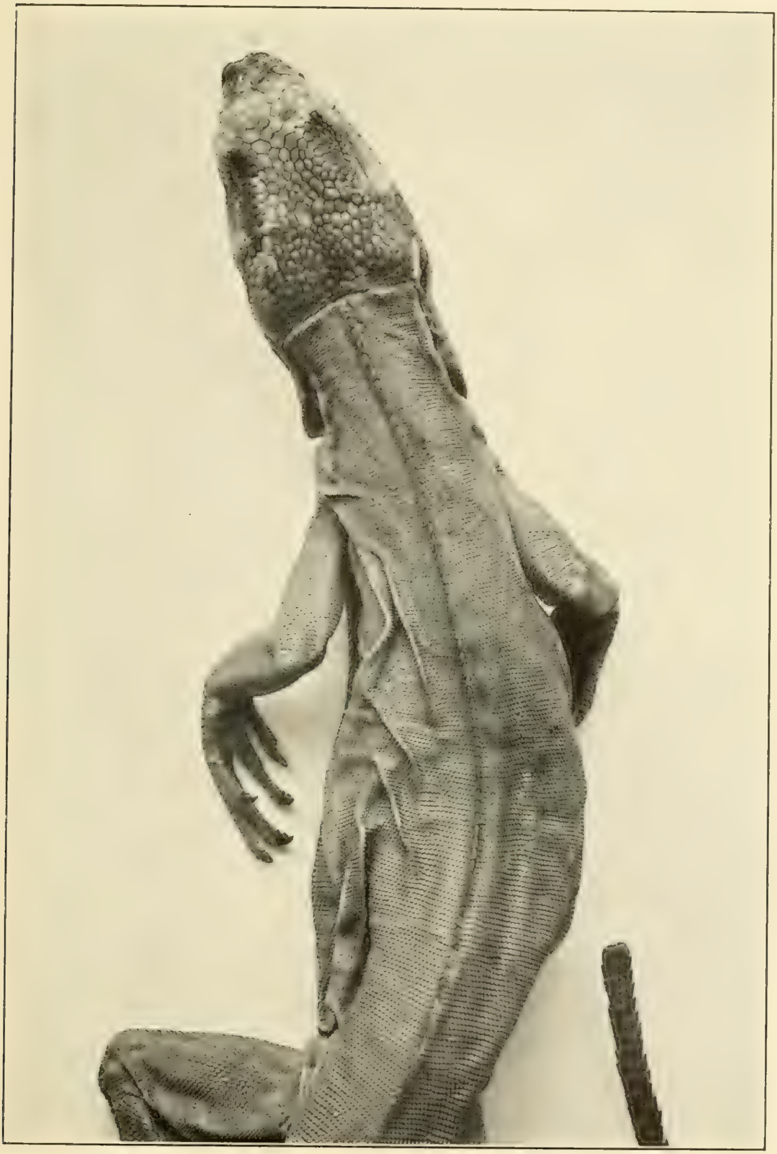
Ctenosaura erythromelas Boulenger. Type, Brit. Mus. Nat. Hist. No. 1. Adult male

PLATE 29

Ctenosaura erythromelas Boulenger. Sacral region and tail of the type. Brit. Mus. Nat. Hist. No. 1. Adult male

PLATE 30

Ctenosaura defensor (Cope). Adult male, M.C.Z. No. 7095



HEAD AND BODY OF FEMALE OF CTENOSAURA ACANTHURA

FOR DESCRIPTION OF PLATE SEE PAGE 52

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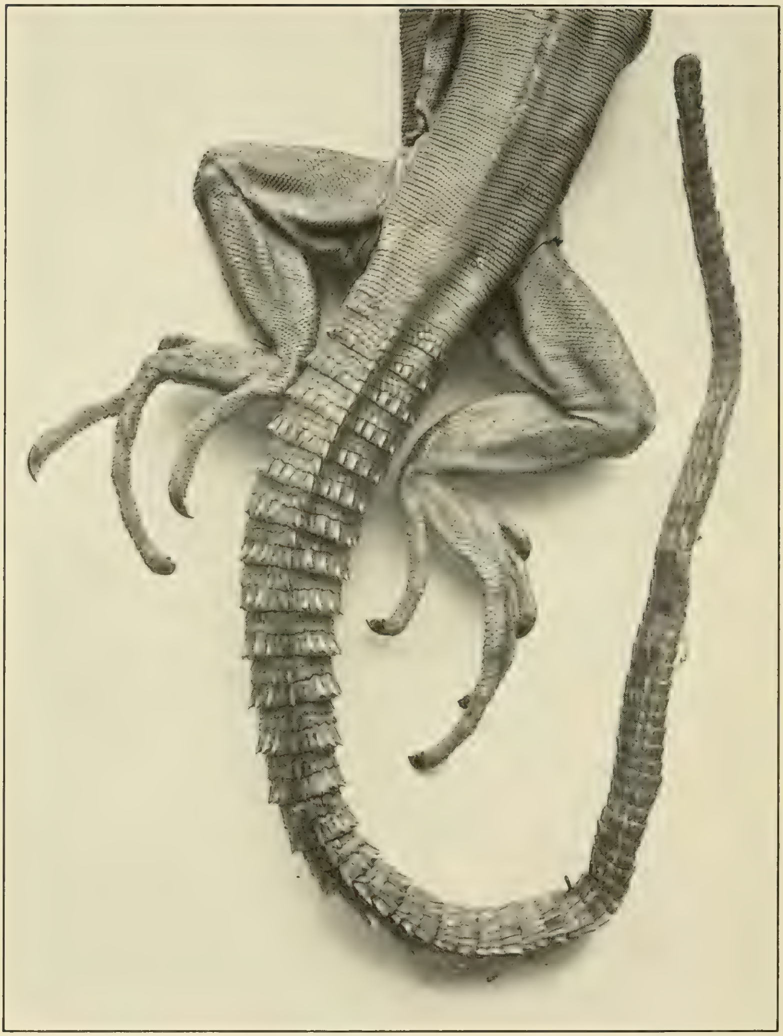


SACRAL REGION AND TAIL OF FEMALE OF CTENOSAURA ACANTHURA

FOR DESCRIPTION OF PLATE SEE PAGE 52

HALF-GROWN MALE OF CTENOSAURA ACANTHURA

FOR DESCRIPTION OF PLATE SEE PAGE 52

Adult Male of Ctenosaura acanthura

For description of plate see page 52

ADULT MALE OF CTENOSAURA HEMILOPHA

FOR DESCRIPTION OF PLATE SEE PAGE 52

STUFFED SKIN OF ADULT FEMALE OF CTENOSAURA BRACHYLOPHA

FOR DESCRIPTION OF PLATE SEE PAGE 52

HEAD AND BODY OF ADULT MALE OF CTENOSAURA PECTINATA

FOR DESCRIPTION OF PLATE SEE PAGE 52

ADULT MALE OF CTENOSAURA PECTINATA

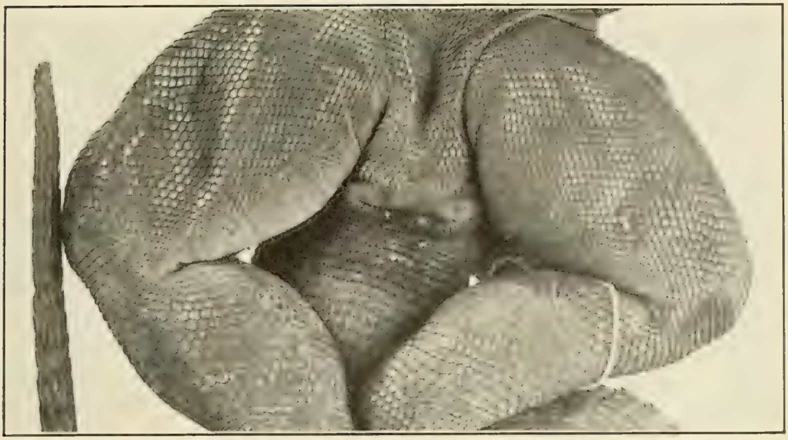
FOR DESCRIPTION OF PLATE SEE PAGE 52

ADULT MALE OF CTENOSAURA PECTINATA

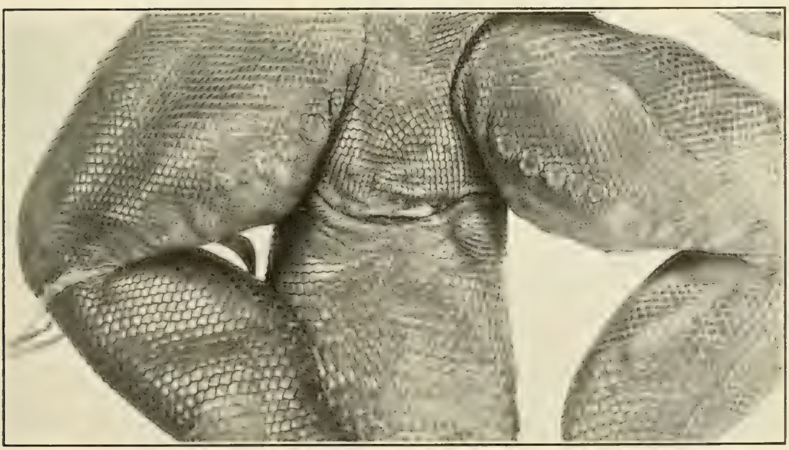
FOR DESCRIPTION OF PLATE SEE PAGE 52

ADULT FEMALE OF CTENOSAURA PECTINATA

FOR DESCRIPTION OF PLATE SEE PAGE 52



FEMORAL PORES OF FEMALE OF CTENOSAURA PECTINATA



FEMORAL PORES OF ADULT MALE OF CTENOSAURA PECTINATA

FOR DESCRIPTION OF PLATE SEE PAGE 52

ADULT MALE OF CTENOSAURA BREVIROSTRIS

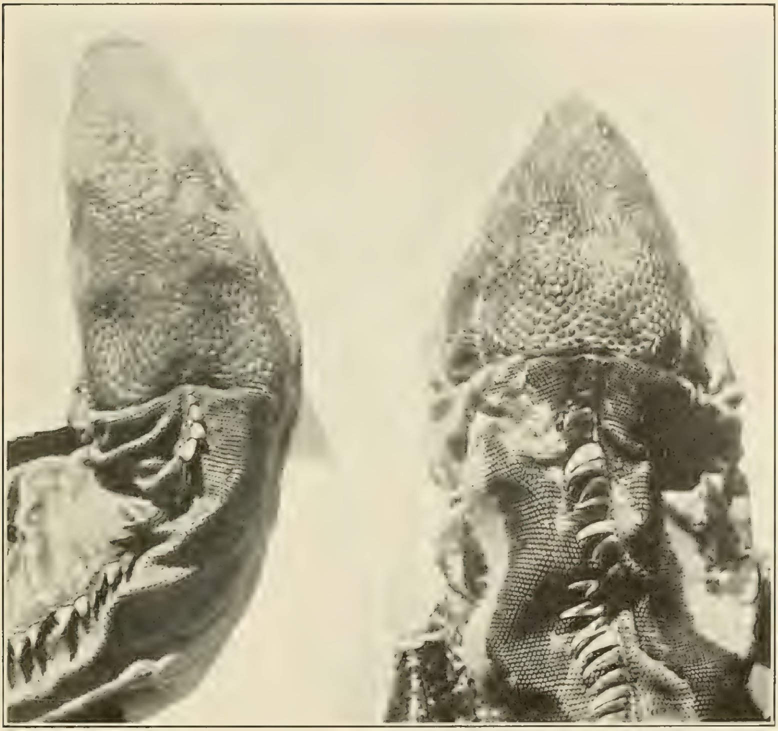
FOR DESCRIPTION OF PLATE SEE PAGE 53

HALF-GROWN MALE OF CTENOSAURA BREVIROSTRIS

FOR DESCRIPTION OF PLATE SEE PAGE 53

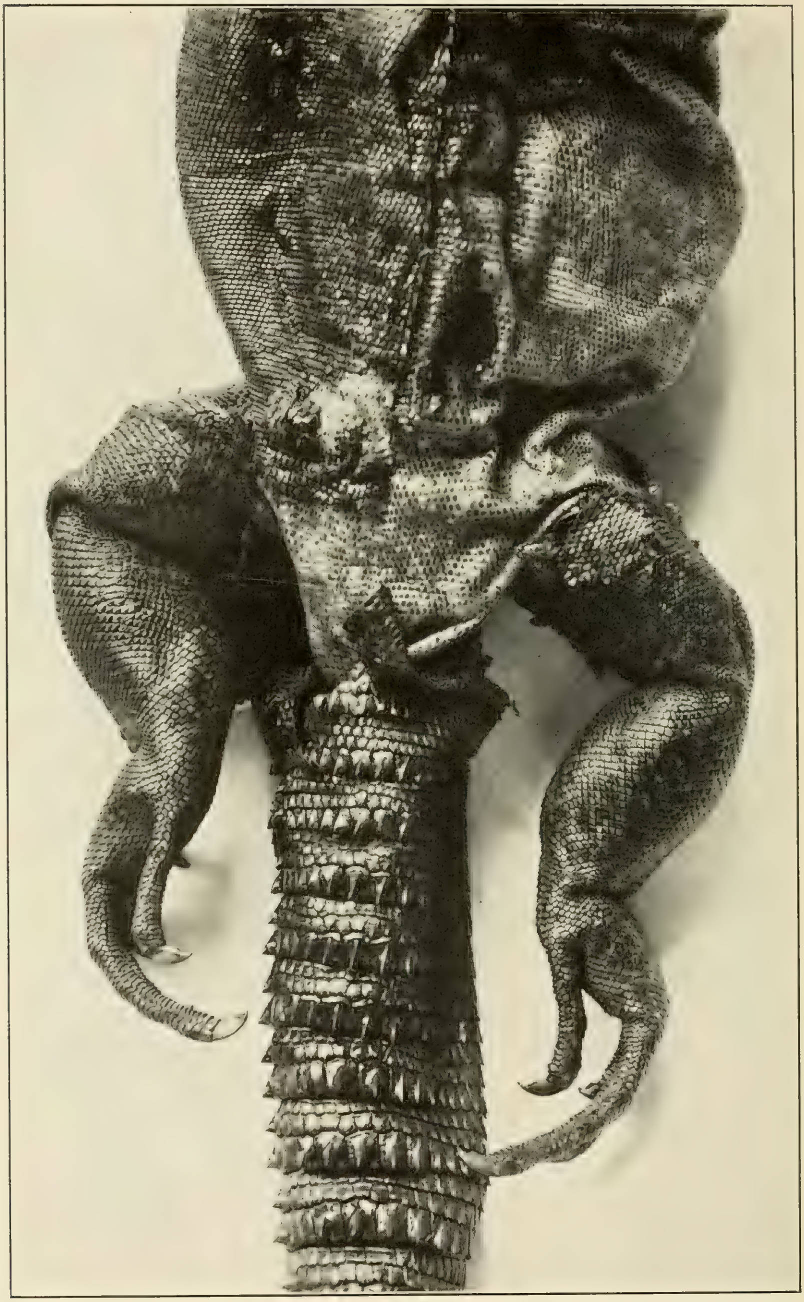
ADULT FEMALE OF CTENOSAURA PARKERI

FOR DESCRIPTION OF PLATE SEE PAGE 53



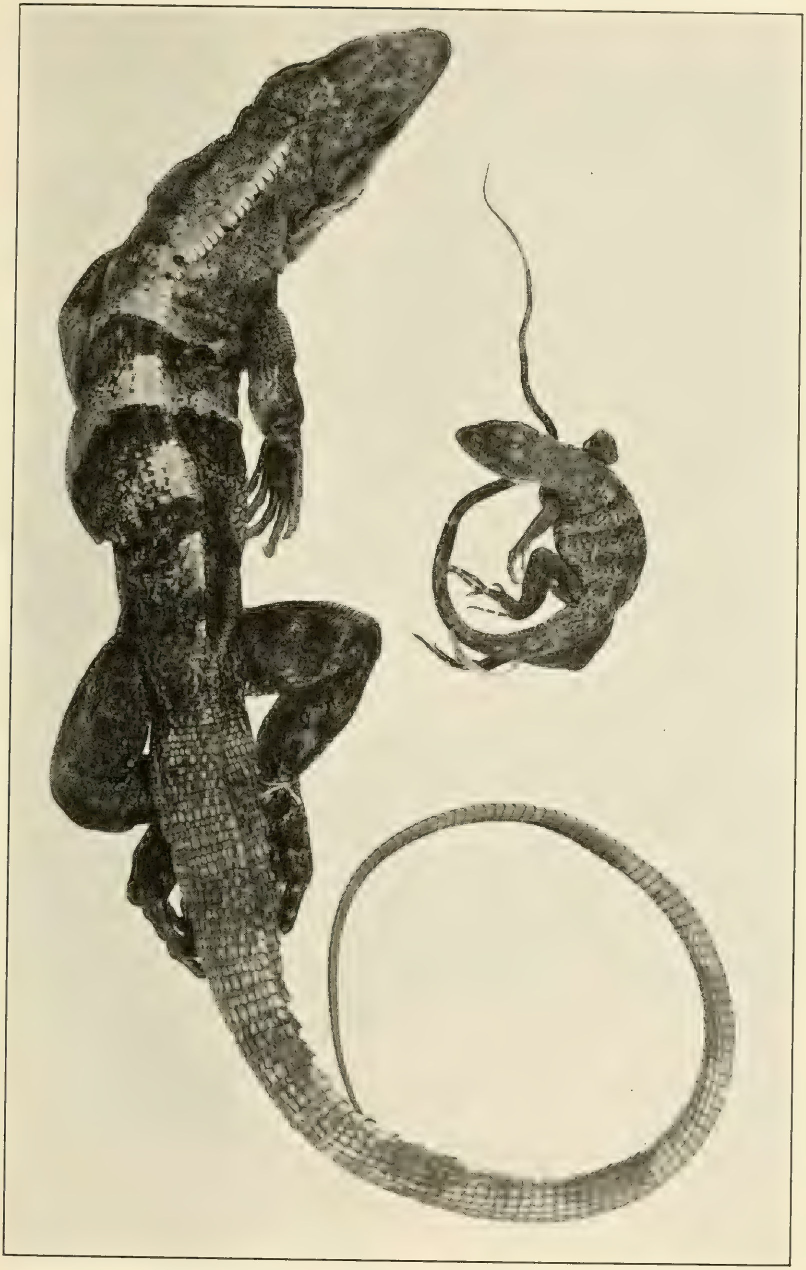
HEADS OF CTENOSAURA PARKERI (LEFT) AND C. BREVIROSTRIS (RIGHT)

FOR DESCRIPTION OF PLATE SEE PAGE 53



ADULT MALE OF CTENOSAURA SIMILIS

FOR DESCRIPTION OF PLATE SEE PAGE 53



HALF-GROWN MALE AND YOUNG MALE OF CTENOSAURA SIMILIS

FOR DESCRIPTION OF PLATE SEE PAGE 53

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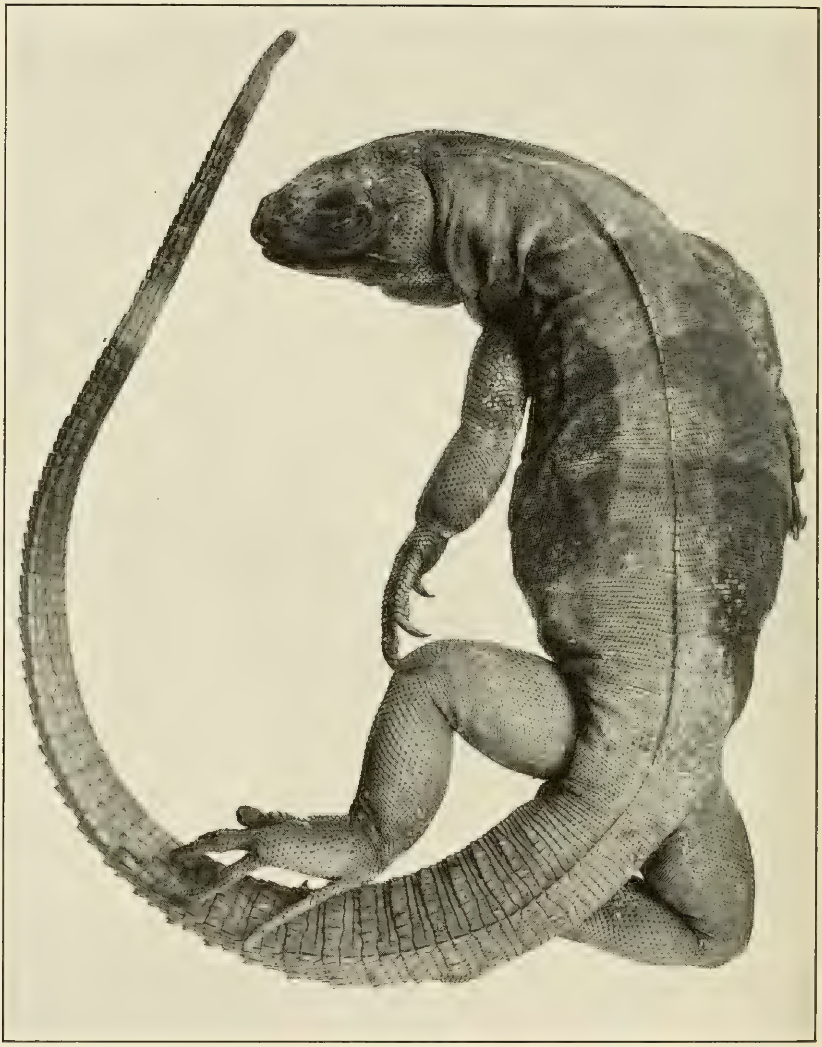

ADULT FEMALE OF CTENOSAURA SIMILIS

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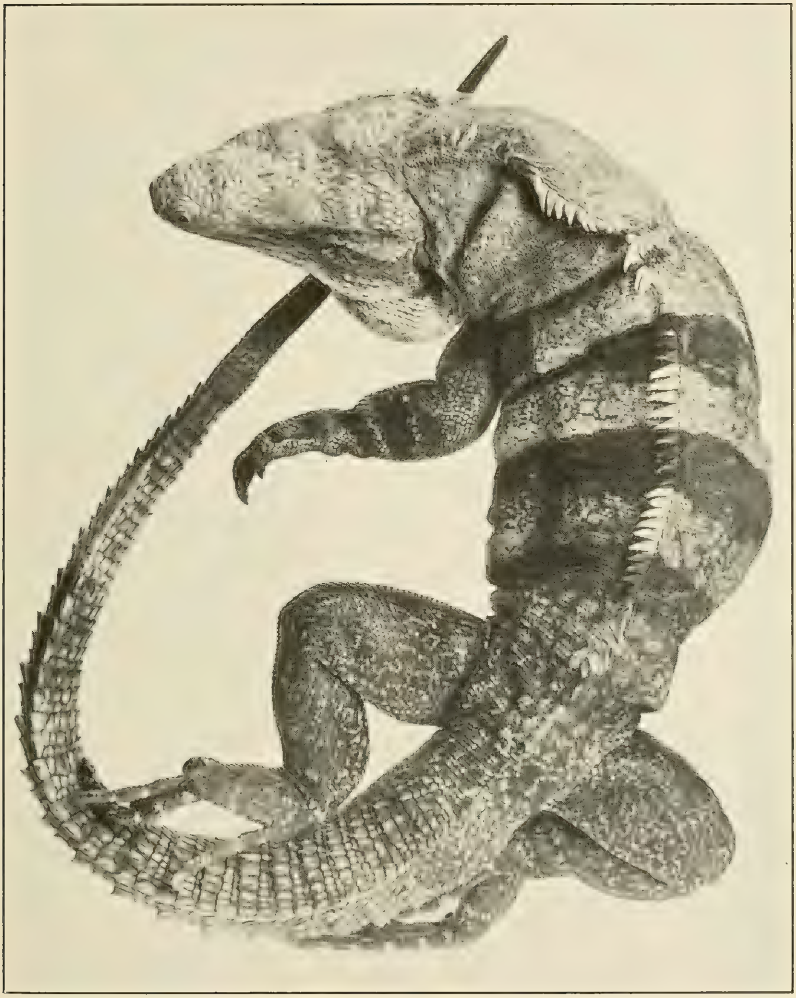


ADULT MALE OF CTENOSAURA SIMILIS

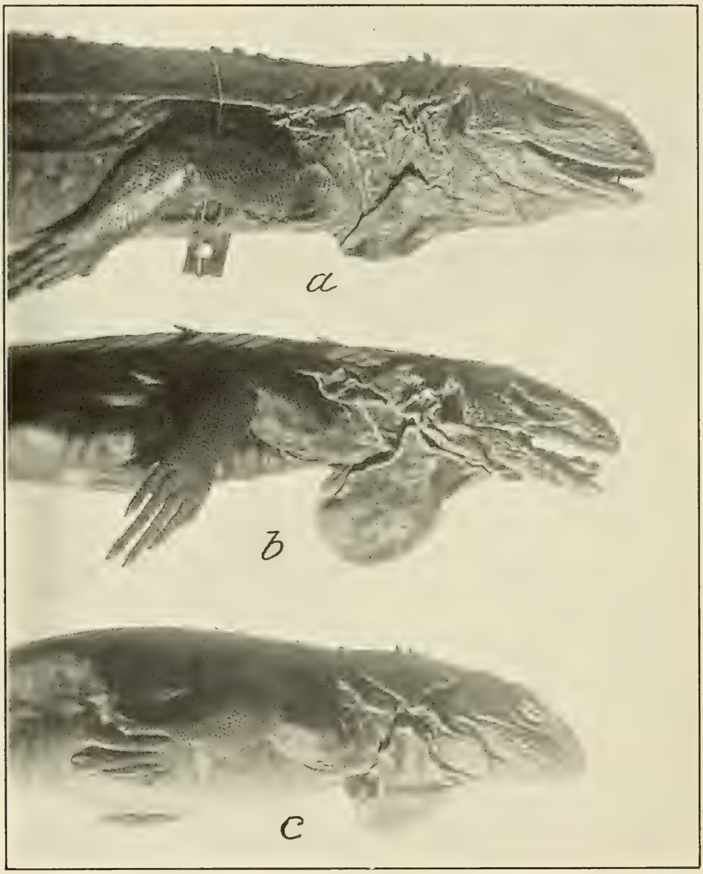
FOR DESCRIPTION OF PLATE SEE PAGE 53

TYPICAL HABITATS OF CTENOSAURA SIMILIS

FOR DESCRIPTION OF PLATE SEE PAGE 53

ADULT FEMALE OF CTENOSAURA BAKERI

FOR DESCRIPTION OF PLATE SEE PAGE 53



THE DEWLAP OF (*a*) CTENOSAURA BAKERI, FEMALE; (*b*) C. PALEARIS, MALE; (*c*) C. PALEARIS, FEMALE

FOR DESCRIPTION OF PLATE SEE PAGE 53

ADULTS OF CTENOSAURA PALEARIS (LEFT) FEMALE; (RIGHT) MALE

FOR DESCRIPTION OF PLATE SEE PAGE 53

SACRAL REGION OF ADULT MALE OF CTENOSAURA QUINQUECARINATA

FOR DESCRIPTION OF PLATE SEE PAGE 53

SACRAL REGION OF ADULT MALE OF CTENOSAURA QUINQUECARINATA

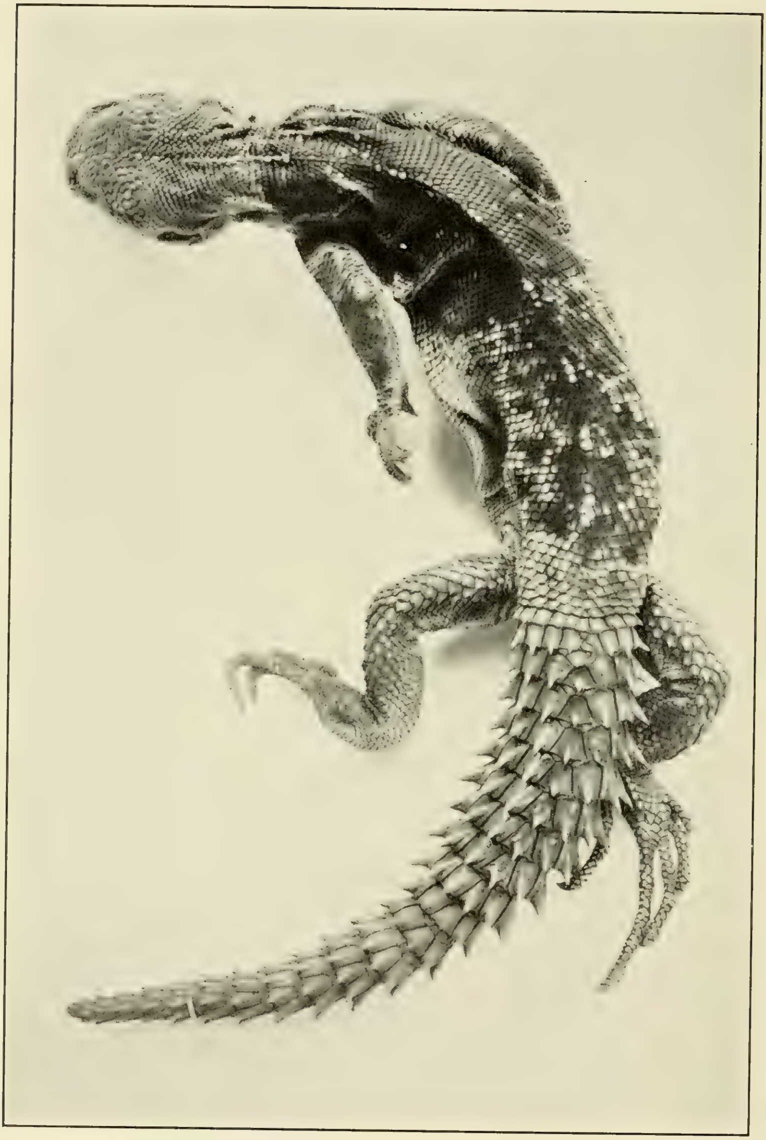
FOR DESCRIPTION OF PLATE SEE PAGE 54

ADULT MALE OF CTENOSAURA QUINQUECARINATA

FOR DESCRIPTION OF PLATE SEE PAGE 54

ADULT MALE OF CTENOSAURA CLARKI

FOR DESCRIPTION OF PLATE SEE PAGE 54

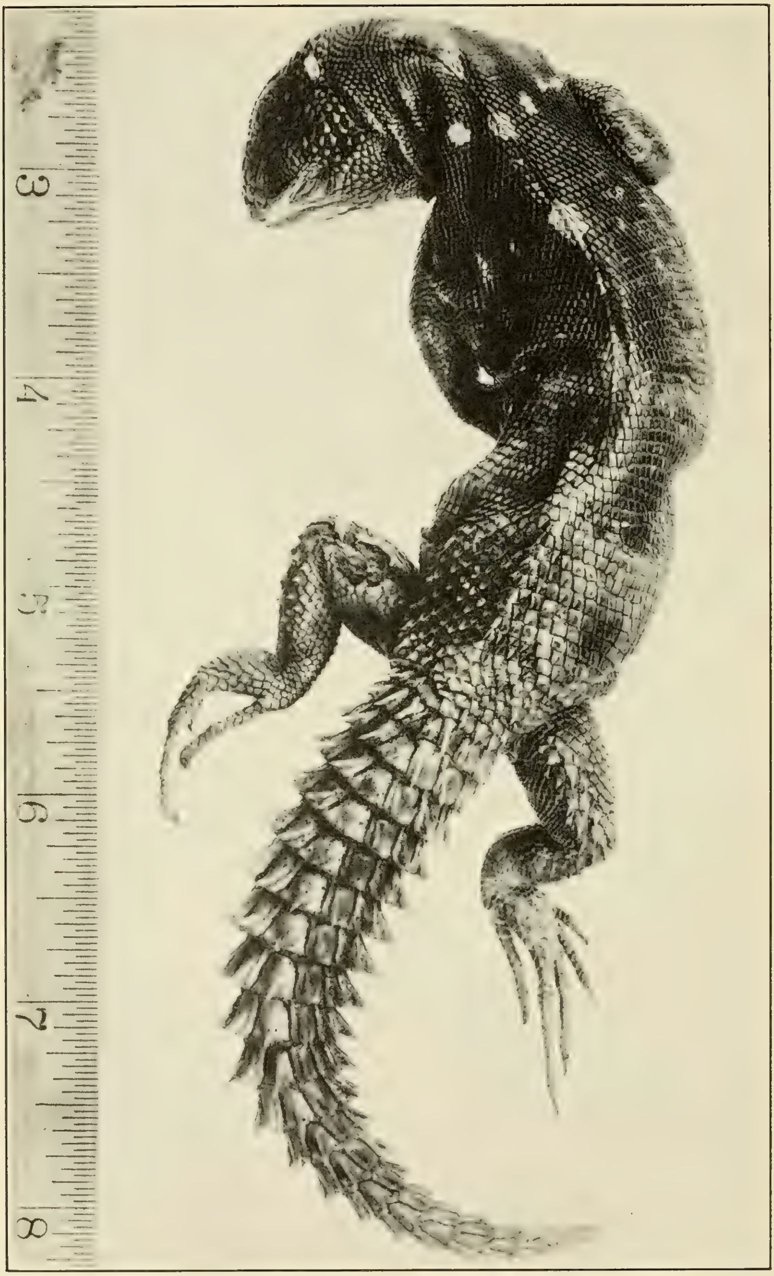


ADULT MALE OF CTENOSAURA ERYTHROMELAS

FOR DESCRIPTION OF PLATE SEE PAGE 54

Adult Male of Ctenosaura erythromelas

For description of plate see page 54



ADULT MALE OF CTENOSAURA DEFENSOR

FOR DESCRIPTION OF PLATE SEE PAGE 54

INDEX

[The following index gives the names of genera and species described in roman, while the synonyms are italicized. The principal references are in boldfaced type]

FOSSIL NUTLETS OF THE GENUS LITHOSPERMUM

By Edward W. Berry
Of the Johns Hopkins University, Baltimore, Maryland

There are in the collections of the United States National Museum some hundreds of silicified fruits collected by the late John B. Hatcher from the Loup Fork formation in 1884 which have never been identified or described. More recently similar material has been sent in from the undifferentiated Tertiary of Kit Carson County in eastern Colorado.

Among these are numerous specimens representing a new species belonging to *Lithospermum*, a genus belonging to the family Boraginaceae and not hitherto known in the fossil state. These show a wide range of variation, but after much deliberation I have concluded that the best method of treatment would be to consider all of them as varieties of a single botanical species which may be called *Lithospermum fossilium*.

The smallest and most abundant variety may be described first as:

LITHOSPERMUM FOSSILIUM RUGOSUM, new variety

Plate 1, Figures 1–10

Nutlets relatively small, averaging about 3 millimeters in length, 2 millimeters in width, and 2.5 millimeters in thickness. They are contracted upward to a distal cuspidate but rounded apex, and are asymmetrically inflated, the outside being much more convex than the inside, both the apex and hilum being nearly in the plane of the less inflated inner side. On the inside a rounded keel extends from the apex nearly or quite to the hilum. The hilum is large and circular, from 0.5 to 1 millimeter in diameter. The surface is rugose but varies from nearly smooth to an aerolation of well-marked ridges. This variation in sculpture is not due to abrasion before or after fossilization, I am quite sure, since it would have been equally effective on the apical point or the delicate rim of the hilum, which is not the case.

Found in both Kansas (figs. 1–6) and Colorado (figs. 7–10).

LITHOSPERMUM FOSSILIUM GLABRUM, new variety

Plate 1, Figures 11–13

This variety is less abundant than the preceding and is known only from Kansas. In form the nutlets are asymmetrical fusiform, being always larger and relatively longer and narrower than var. *rugosum.* The apex is usually more distinctly cuspidately pointed, the keel on the inner face is less pronounced, and the base is contracted to a narrower hilum. The surface is smooth and polished. It is difficult to determine the extent to which the apex was produced, since it is so readily broken off, and it is usually impossible to detect evidence of fracturing, but there is some evidence of a small amount of elongation. Length, ranging from 3.5 to 7 millimeters. Width, ranging from 1.5 to 3.5 millimeters, and thickness ranging 1.5 to 3.5 millimeters. The seed coat as preserved is one-fourth to one-eighth of a millimeter in thickness.

Phillips County, Kans. (Figs. 11 to 13.)

LITHOSPERMUM FOSSILIUM ARISTATUM, new variety

Plate 1, Figure 14

This variety is rarer than either of the preceding, probably because the seeds are much more fragile. I judge this conclusion to be correct, because among 20 specimens only the one figured has the apical spine preserved for any distance and nearly all have the seed coat more or less broken. This variety is more slender and elongated than either of the others and is more symmetrical in side view and nearly circular in transverse section. The base is contracted to a hilum about the size of that in var. *glabrum.* The apex is produced as an attenuating spine which may be two-thirds as long as the inflated portion. The keel, though obvious, is less elevated. The surface is smooth and polished. The size varies considerably. The dimensions, exclusive of the spine, which is so rarely preserved, range from lengths of from 5 to 10 millimeters and diameters of from 1.5 to 3 millimeters. The material does not permit of a determination of the constancy or length of the spines.

Phillips County, Kans. (Fig. 14.)

This is the most remarkable of the variants of this species. I know of no instance among the existing members of the families Boraginaceae, Verbenaceae, and Labiatae where the four-parted ovary develops into four nutlets where these are crowned with anything approaching the spines of this fossil variety. That this variety is related to the others is clear by the similarity between it and the shorter pointed variety *glabrum*, with which it is associated.

The genus *Lithospermum* comprises about two score existing species of annual or perennial herbs, widely scattered in prevailing dry soil habitats, mostly in the Northern Hemisphere, but sparingly represented in South America and Africa. The four-parted ovary develops into four or fewer hard nutlets of rather characteristic shape and with smooth and polished or wrinkled and pitted bony coats.

I have reproduced nutlets of several recent species for comparison with the fossils. The fossil variety *rugosum* is, in both size and form, much like the nutlets of the existing *Lithospermum linearifolium* Goldie, shown in side and inside view in Figures 15 and 16. This is a wide-ranging North American form found in dry situations from Manitoba to British Columbia and southward to Illinois, Texas, and Arizona. The species *L. arvense* Linnaeus has a similarly roughened surface.

The fossil var. *glabrum* is approached by a considerable number of existing species with hard, smooth surfaces. Of these I reproduce two, namely, *L. ruderale* and *L. pilosum*. (Figs. 17, 18, 19.) Both approach *glabrum* in size and form, but differ in their greater width and larger hilum.

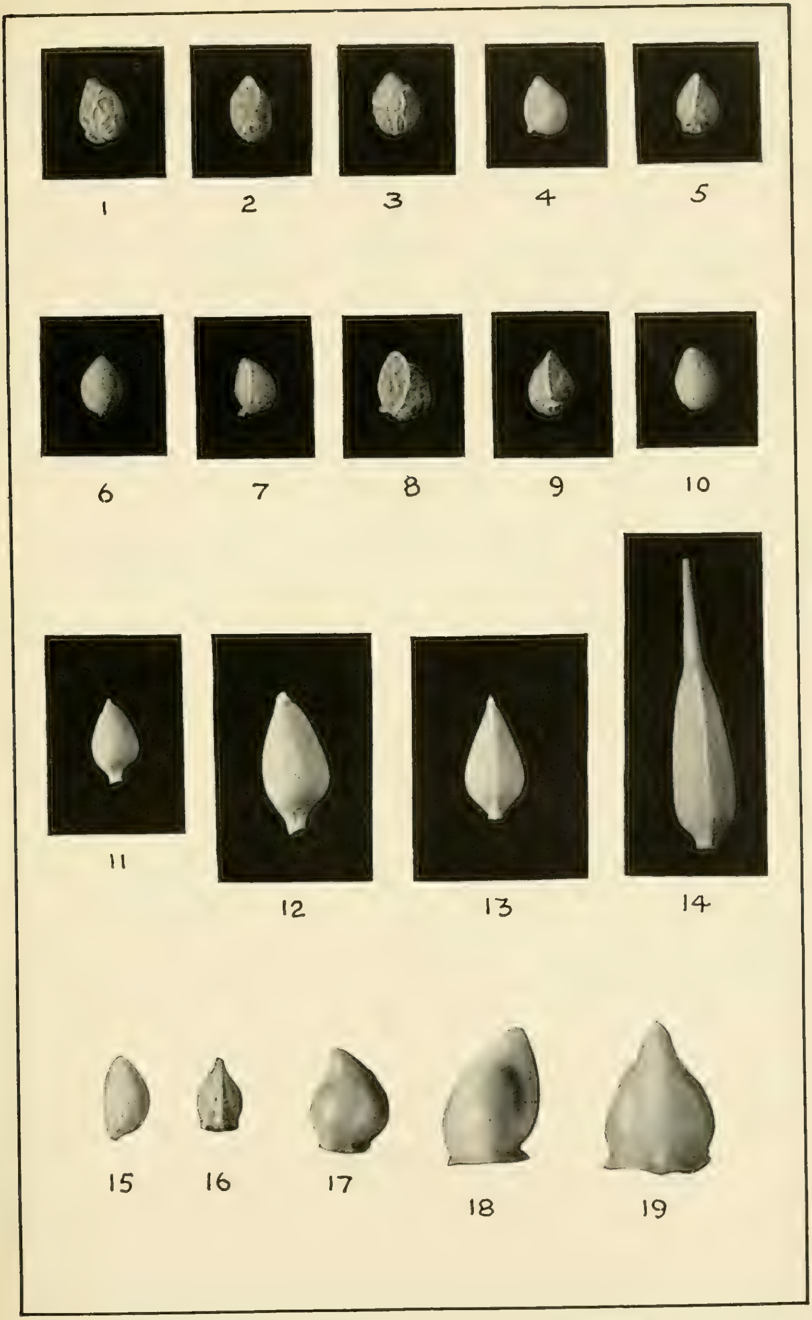
I have seen nothing among the modern forms which closely resembles the fossil var. *aristatum*. Other species than those reproduced would serve equally well for comparison and illustration, but I have not been able to see fruits of all of the species.

EXPLANATION OF PLATE

FIGS. 1–10. *Lithospermum fossilium rugosum*, new species.
1–6. Phillips County, Kans.
7–10. Kit Carson County, Colo.
11–13. *Lithospermum fossilium glabrum* Berry, new species.
Phillips County, Kans.
14. *Lithospermum fossilium aristatum* Berry, new species.
Phillips County, Kans.
15, 16. *Lithospermum linearifolium* Goldie.
15 from side.
16 from inside.
17. *Lithospermum ruderale* Linnaeus.
From side.
18, 19. *Lithospermum pilosum* Nuttall.
18 from side.
19 from outside.

All enlarged three times.

O



FOSSIL NUTLETS OF THE GENUS LITHOSPERMUM

FOR EXPLANATION OF PLATE SEE PAGE 3

FIRE-MAKING APPARATUS IN THE UNITED STATES NATIONAL MUSEUM

By Walter Hough

Head Curator of Anthropology, United States National Museum

INTRODUCTION

In the ethnological collections of the United States National Museum at the period of 1886 there were many fire sticks, chiefly from the North American Indians, and from the Eskimo, with a few from other parts of the world. Prof. Otis T. Mason, then curator of ethnology in the newly organized Museum, observing the interest of his aide in these curious objects, urged him to take up their study. In this opportune time, 42 years ago, the constant stream of ethnological material flowing into the Museum from expeditions brought with it other fire sticks, until a sufficient basis for their scientific description was assembled. From the first in the National Museum organized by G. Brown Goode on the basis of arts and industries it was regarded as a necessity to practically work out the method by which the aborigine produced the impedimenta which supplied his needs. Thus before the writer could intelligently handle the subject of aboriginal fire making he should be able to make fire by all the methods known to man. This unexpectedly difficult task accomplished, the first practical monograph on the subject appeared.[1] It was found possible in the study to classify the methods and assign them to races and geographic areas and also to give a synopsis of the technical and developmental status of the methods. The widespread interest in this subject was demonstrated by the demand for the paper, which has been placed out of the reach of collectors for many years. The present paper is a revision and extension of the former publication.

The following is a classification of the chief methods of fire making, based upon the presumed order of development:

[1] Hough, Walter. Fire-Making Apparatus in the U. S. National Museum, An. Rep. U. S. Nat. Mus., 1888, pp. 531–587.

I. On wood (reciprocating motion) by—
1. *Simple two-stick apparatus.*—Indians of North, Central, and South America; Ainos, Japan; Somalis, Africa; most Australians, etc. The most widespread method.
2. *Four-part apparatus; mouth drill and two-hand drill.*—Eskimo, some Indians, Siberians, Hindus, and Dyaks.
3. *Compound, weighted drill.*—Iroquois and Chukchis.

II. On wood (sawing motion with knife and thong).—Malays and Burmese.

III. On wood (plowing or planing motion).—Polynesians; some Australians.

IV. Of minerals and bamboo (percussion).
1. *With pyrites (or stone containing iron) and flint.*—Eskimo and Indians of the North (Algonkian and Athapascan stocks).
2. *Flint and steel.*—Modern and disused methods and appliances.
3. *Flint or other hard substances on bamboo.—Malay.*

V. By compressed air.

Besides the lens, mirror, and aerophore there are pyrophores, the hydrogen lamp, matches, and various chemical and electrical methods.

FIRE MAKING BY ARTIFICIAL MEANS

Observations on the customs of the races of mankind, extending in time and area, show that by one or more of several methods all men knew how to make fire artificially. The origin of fire making is evidently lost in the past, but there is no valid reason to put the invention very far back in time. Sound criticism will place it at the period of one of the profound advances marked by new ideas and the beginnings of the great movement of the dissemination of man over the earth. Several deductions are legitimate concerning the nebulous period when the art of fire production was in the making. The first of these is that fire was carefully preserved when no means of lighting it again were at hand and fire occurring in nature from the lightning and volcano was difficult to obtain. Hence the ancients of the early world of man learned all there was to know about the guardianship of fire and were also frugal in the use of this "friend of man."

Another deduction is that there is more or less uncertainty in carrying fire about, especially to any distance, under primitive conditions. If fire was as important to man as has been imagined, he would not for a long time migrate from his primitive seats.

It is not possible to imagine man, undoubtedly a creature of long development and with a long train of acquired experiences, remaining

in one place like other animal groups. With the use of tools, the ownership of fire, organization based primarily on instinct and more importantly on ideas, man presents himself as a candidate for the conquest of the earth. We know that a very long time ago men in the fire-preserving stage spread over large areas in Europe, lived there for millenniums, and passed on. Other areas in western Asia and northern Africa were also found to show evidence of the presence of early man. The continuing thread that runs through this mass of material culture of man is progress. The sum is progress, irrespective of the involved and doubtful questions concerning the time and the man himself. It is not known whether some groups of early man migrated without fire or whether at times fire was lost and became forgotten. Our theories that fire is indispensable to all humankind under all conditions are subject to modification. It is curious that very many fire myths recount a stage of firelessness and a wresting of fire from those having it. Myths are regarded by scientific men as having a substantial basis of fact and it must be concluded that the fire myths indicate that some groups of men were fireless. No such condition of things has ever been observed among the tribes of modern or historical man. The myths, therefore, may be considered as portraying conditions of considerable antiquity.

It may be assumed, therefore, that for a very long period man, possessed of fire and tending it with skill and care, did not know any method of making it at will. How the making of fire artificially came to be developed, for it was a development and not a discovery, can never be known. Which of the methods takes precedence over the others is also uncertain, but from the facts presented it would be argued that wood methods occurred prior to mineral methods.

The first makers of fire may have been confined to a single social group, clan, or tribe. Among observed tribes instances are many where the art of generating fire by wood friction was jealously intrusted to one or a few individuals. Even among the cultured nations of antiquity there is evidence that fire making was never generally practiced by the common people. Tribal possessions of land, minerals, animals, and plants, as well as tribal secrets, form a phase of observed aboriginal life. They are in the class of village industries or the arts and industries of smaller social units possessing workers of skill. Many of these special arts arise on the coalescence of human units into larger social aggregations rather than by derivation by the methods of acculturation as usually understood. In this sense fire making artificially would originate in larger groups where the contact of minds is more stimulating to invention. Such things were at first kept secret under clan custom, dominance of the priesthood, or for other causes, but in the course of time the technical process became

common property and the esoteric sides remained in the care of religious organizations.

The thought on the origin of fire making has tended to vision the human need, and to consider the need supplied by an inventor, much as wonder-working inventions are brought out nowadays. It will be shown that nothing could be farther from the facts. In considering the difficulties which confronted the inventor of the wood-friction fire-making apparatus it is pointed out that the proper wood in proper condition must be found. All advanced Boy Scouts will subscribe to this. Evidently the wood was not selected by the early experimenters before they knew what was to be done with it. Again, the trap for the fire is a slot or channel cut in the horizontal piece, termed the "hearth." This slot is, advisedly, a great discovery. Tinder of a suitable kind in which the spark may be nourished must be found, and this is no small task. Finally the little coal of fire can be brought to a blaze only with great skill and a knowledge of a number of things. These are the chief matters of difficulty connected with the invention of fire making brought out in actual experiment, but there are other minor steps in the process which are seemingly inconsequential yet are vital to efficiency.

It is necessary, then, to vision a long preliminary period during which man gained a growing acquaintance with the properties of various substances which were immediately useful to him in various ways. He knew from the first fire that wood was the fuel which burned on his primitive hearth. He may have thought that fire ate wood, but the chief lesson was that wood burned. Other associations of wood with fire may have come from work with this substance. Friction is a common experience and handling wood or working in wood might give to keen perceptions an odor, a vapor of smoke, suggesting that there was fire present. Unconsciously perhaps these observations led to more knowledge and gradually to an awakening to a combination of these experiences into something useful, and the fire drill, let us say, followed. Why the drill was the form the fire kindler took is not difficult to imagine. The drill is an ancient and primitive tool supplying the need for piercing holes in various materials. It is the result of diverse means employed to pierce holes, such as scraping, punching, grinding, cutting, and breaking, the processes described being variants of the making of holes. From these experiences came finally the drill more especially as a tool for piercing hard substances requiring abrasive processes. Thus when the culmination of the protracted experiments was about to be reached there was a drill which could be adapted to the service of fire making. The Hindu fire-origin myth most practically states that the carpenter with his drill first elicited the divine fire. In its present state the Aryan Hindu myth places the origin of artificial fire making at a

period of social organization in which occupations as of woodworking were followed, indicating a comparatively late event as suggested.

FIRE MAKING WITH THE TWO-PART DRILL

Making fire with the two-part drill is not difficult. The apparatus is designed to render fire making easy, yet with two sticks in hand and no knowledge of the details one is placed practically in the position of primitive man. The drill is a straight, stiff, dry, slender, smooth rod, the diameter of a lead pencil or larger, as shown in the specimens used by various tribes, and up to 20 inches long, but rarely shorter than 12 inches. The hearth admits of far greater variety of form. The large majority, however, are straight-growing sections thicker than the drill and of the same wood. Many of the hearths appear to have been gathered haphazard as a good piece of wood was found, many others are fashioned in a workmanlike manner with flat sides and squared edges, while others are carved and shaped according to the fancy of the native artists.

Having the two essentials and provided with tinder and accompaniments for getting a blaze it is possible to describe in detail the making of fire. We round the lower end of the drill and make a slight holding notch near the border of the hearth in which to start the drill rotating, and we cut a clean, vertical slot from the notch down the edge of the hearth. This slot should be cut deep enough to divide the pit in which the drill operates nearly halfway. Place the hearth on the floor or on firm ground, kneel on one knee, and hold the hearth firmly with the other foot. Take the drill between the extended hands, set the rounded end in the notch, and roll it between the palms, pressing down at the same time. After a few rotations the drill will have bitten into the wood and the dust ground off fallen down the slot, which explains its purpose. Remove the drill and make sure that the slot is central with the hole, also that the drill end is not binding, and if so, whittle it a bit to insure its working freely. Before beginning again it must be understood that the work should be carried on to the finish without displacing the drill from its socket. Also, when rotating the drill the hands will gradually move to the lower part of the shaft. At this juncture grip the drill with one hand, bring the other up to the top, grip the drill with it, and hold it while the other hand can be brought to the first position. By practice this can be done so quickly that no apparent cessation of the drilling is observable.

To resume the effort to make fire it is better to revolve the drill slowly at first, gradually increasing the pressure till the dust darkens somewhat and smoke arises, then quicken the stroke and pressure to the extreme till the carbonized wood dust pushes down the slot in a coherent roll. If a thin vapor arises from the dust the work has been

a success. Shortly a little coal of fire will be seen. To get a blaze from this fragile coal is like Langley's problem in launching the first airplane; the difficult problem which was hardly visioned in the more important effort.

There are, of course, a number of minor variations in the procedure. The coal may be very gently fanned where it lies and finely divided material added in right amount. Generally, softened inner bark strips are previously placed under the hearth and shredded grass or bark with perhaps a bit of tinder placed near the slot. The coal emerges in this material, which is taken up on the strips of bark and gently waved in the air. In a little while a flame bursts forth.

FIRE MAKING WITH THE FOUR-PART DRILL OR BOW DRILL

The explanations referring to the hand drill also apply to the bow drill in everything except in the handling of the machine which supplants the bare and often excoriated palms of the would-be primitive fire maker. The aboriginal bow is rigid, straight, or slightly curved and from 10 to 20 inches long. The cord of buckskin or hide is tightly fastened to one end and can be adjusted at the other to take up slack. The drill is usually of larger diameter and shorter than the hand drill, and tapered toward the ends from the middle. The nut is a block of wood, generally carved in form of an animal among the Eskimo, of convenient size for holding in the hand, and set with a piece of soft, easily polished stone such as marble or soapstone in which a cavity has been made. Make one turn of the cord around the drill, leaving the bow to the right, set the drill in the socket of the hearth, and place the nut. Make a few turns to ascertain conditions, especially whether the cord grips the drill sufficiently to not slip when pressure is applied on the nut. The position of the driller is over the drill, the left hand holding the nut being brought around the left flexed knee, which aids pressure on the drill. Begin slowly and increase pressure, nicely balancing the pressure with the grip of the cord. In the concluding rapid work the cord may be tightened by pinching it up between the thumb and first finger of the right hand. When the drill is felt to bite strongly into the wood and throws up a little smoke increase the pressure and rotation until the fire coal is thought to have appeared. Hold the drill in place till this fact is known, as it is much better to continue with a hot drill than a cold one.

With the fire plow we have another idea radically different from the drill. In this case a blunt stick is held between the locked fingers, pressed down firmly, and rubbed back and forward on the flat surface of a horizonal hearth, cutting a groove and forcing the dust into a little heap at the end of the groove, and in which the fire rises. As in the drill, this method requires careful and assured movements, calculated to a nicety lest the accumulation of dust be disturbed. At

the culmination of the effort the rubbing stick is raised to a higher angle so that it will bite more strongly.

The fire saw offers another curious method which is nearer to the fire plow than to the drill. The fire saw is almost invariably of bamboo, to which the method conveniently adapts itself. A bamboo joint is split into halves; from one is fashioned the sawing part in form of a strip with a sharpened edge. In the concave of the other half a few slivers are raised to hold a piece of tinder. This is set on the ground convex side up and the saw is swiftly rubbed across at right angles and over the the cage holding the tinder. The saw soon cuts through the wall of the bamboo and at its hottest comes into contact with the tinder, which is ignited.

A related form is the fire-thong apparatus, which consists of a stick either split and wedged apart, as shown in Plate 9, or having a horizontal slot cut through the middle. A bit of tinder is stuck in the slot; the cord, which is a rattan length, is passed under the stick at the tinder and pulled up and down, shortly igniting the tinder.

QUALITIES OF WOOD

It is found by experience that the qualities rendering wood suitable or not for fire making are as follows: Wood with fine grain, or without grain, as in deadwood, and wood decomposed to a certain extent, and stalks of yucca and other vascular flower stalks are to be chosen; new wood, or wood containing certain products of growth, such as gums, resins, starches, sugars, and tannic acid, will not produce a fine, dry, inflammable powder; and, in general, hardwoods are to be rejected.

In selecting wood judgment must be exercised after the manner of aboriginal man, who desired wood that was dry, soft, of proper grain, and inflammable, and as a result his selection was nearly always of deadwood. Some woods, however, thoroughly dried and seasoned, will answer very well. In many cases wood must be tested with the drill and discarded if the dust rubbed between the fingers is gritty. Also, one part only of the chosen wood may be good.

The following American woods are suggested for fire making. Those queried may be valuable if in proper condition as mentioned. Hemlock, willow, elm, soft maple, sycamore, tulip (?), cedar, cottonwood, balsam (?); poplar, silver, Lombardy; white pine (?) and yucca, flowering stalk.

There are introduced here the explanation of two plates of a series exhibited in the United States National Museum illustrating the presumed development of the art of fire making.[2]

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[2] Extracted from Proceedings, U. S. Nat. Mus., vol. 60, No. 2404, 1922, pls. 1 and 2.

No. 1. Volcano in action; lava setting fire to forests. Water-color drawing. 178157.

No. 2. Lightning setting a forest on fire. Water-color drawing. 178158.

No. 3. Camp fire; man borrowing fire. Water color drawing. 178159.

No. 4. Fire saw. Strip of bamboo drawn across a section of bamboo. Dyaks of Borneo and other Malays. 178152.

No. 5. Fire thong. Rattan thong drawn over a grooved piece of wood. Dyaks of Borneo. 178152.

No. 6. Fire plow. Blunt stick worked along a groove in a lower stick. Polynesians. 178152.

No. 7. Fire drill. Slender rod twirled between the hands upon a lower stick having a cavity with slot. Indians of the United States and widely diffused in the world. 176353.

No. 8. Fire drill. Rod held in a socket and gyrated by means of a cord. The lower piece of wood has a cavity with slot opening upon a shelf. Eskimo of Alaska. 127644.

No. 9. Fire drill. Rod held in a socket and gyrated with a bow and cord. Lower piece with cavities on a central groove. Eskimo of Alaska. 48078.

No. 10. Fire drill. Pump drill used specially for sacred fire. Iroquois Indians, Canada.

No. 11. Strike-a-light. Flint and iron pyrites struck together as the ordinary flint and steel. Eskimo of Alaska. 178154.

No. 12. Strike-a-light. Flint and steel and box for holding flint, steel, and tinder. Sulphur-tipped splint ignited from the tinder. England. 130436.

No. 13. Strike-a-light. Bamboo tube and striker of pottery used as flint and steel. Two boxes for tinder. Malay.

No. 14. Tinder pistol. Gunlock adapted for throwing sparks into tinder. England. 175712.

No. 15. Strike-a-light. Combination of flint, steel, tinder, and extinguisher for carrying in the pocket. Spain. 178155.

No. 16. Fire syringe. Cylinder with closely fitting piston bearing tinder. Driving the piston down smartly kindles the tinder. Siamese and Malays. 176091.

No. 17. Lens. Used for producing fire by focusing sunlight upon tinder. Ancient Greeks. 178151.

No. 18. Hydrogen lamp. Hydrogen gas is made to play upon spongy platinum, causing it to glow. Germany, 1824. 165440.

No. 19. Match light box. Bottle of sulphuric acid, into which splints tipped with potassium chlorate and sugar were dipped. Vienna, 1809. 151711.

No. 20. Matches. Various kinds of phosphorus matches. 178156.

No. 21. Electric gas lighter. Cylinder containing a small dynamo run by pressure of the finger, producing sparks between the points at the upper end of the tube. United States, 1882. 200512.

The means of applying forces for making fire may be classified as below in the order of their utilization:

Frictional, drilling, sawing, plowing on woods.

Percussional, striking pyrites, flint and pyrites, and flint and steel.

Physical, compression of air, platinum sponge, lens, mirror.

Chemical, chemical combination as matches, sodium, pyrophores, etc.

Electrical, electrical energy, sparking apparatus.

ETHNOGRAPHY OF FIRE-MAKING APPARATUS

I. FIRE MAKING BY RECIPROCATING MOTION

1. *Simple two-stick apparatus.*—This method may be said to have a world-wide distribution and to have had no narrow range in time. It is a very interesting study to observe the many different practices that have been superadded to the simple task of twirling two sticks with the design of creating fire. It is also instructive to note how fixed have become tribal characters in so small a thing as the shaping of the elements of the fire drill. It has well been said by Doctor Schweinfurth that:

> A people, as long as they are on the lowest step of their development, are far better characterized by their industrial products than they are either by their habits, which may be purely local, or by their own representations, which (rendered in their rude and unformed language) are often incorrectly interpreted by ourselves. If we possessed more of these tokens we should be in a position to comprehend better than we do the primitive condition of many a nation that has now reached a high degree of culture.[3]

This fact holds good with reference to tribes in a higher plane than the learned writer included in this statement, in this way: There are many little things that have not been subject to the modification of time, intercourse, or environment, but coexist with an art. To particularize: Prof. E. S. Morse has shown the value of the simple act of releasing an arrow from a bowstring as a classifier. Close attention to the minor acts and arts will reveal much more than the nice measurements of man's practically unmodified skeleton.

Differences that have become functional in the arts have come down from an early period; when they can be found they are of the greatest value as aids in ethnology.

The ethnography of the simple fire drill is studied geographically, beginning in North America with the most northerly tribes that use it, and ranging from north to south in the different sections of the country, among the tribes from which there are specimens in the Museum. Other countries are examined from west to east.

The Sitkan fire-drill spindle is unusually long and thick. (Fig. 1.) Both hearth and drills are of the *Thuja gigantea*, a tree that enters so largely into the life of the Indians along this coast. The wood grinds off very well with much friction; at ordinary speed there is soon a small heap of powder at the bottom of the fire slot. The latter is deeply cut in from the side nearly to the center of the fire hole. The whole hearth has been charred at the fire. This repels moisture, and also renders it easier to ignite the wood, charring being a process somewhat analogous to the decay of wood by rotting. If kept carefully in a dry place, this apparatus was perfectly adequate for the

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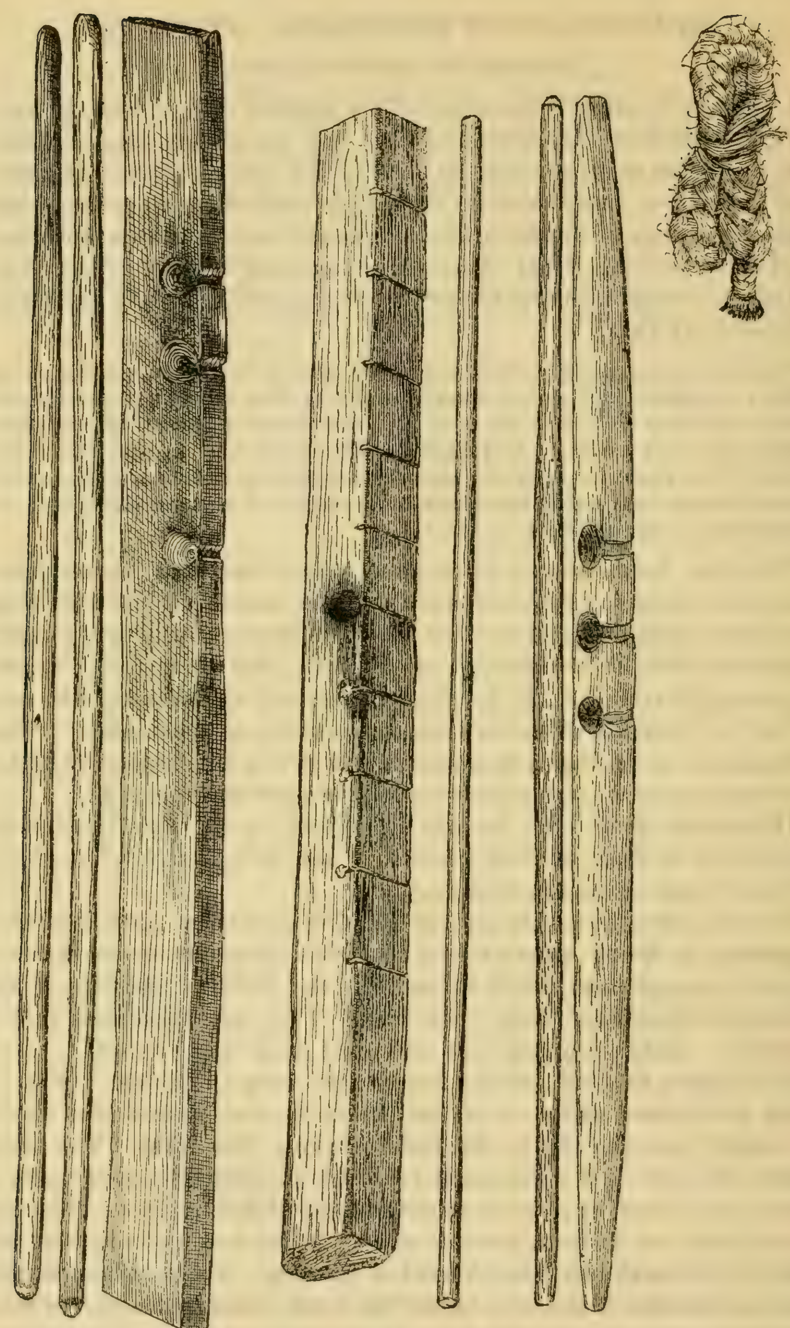
[3] The Heart of Africa. New York, 1874, vol. 1, p. 257.



1 2 3

FIGS. 1–3.—1, FIRE-MAKING SET. CAT. NO. 74379, U.S.N.M. TLINGIT INDIANS, SITKA, ALASKA. COLLECTED BY JOHN J. MCLEAN. 2, FIRE-MAKING SET. CAT. NO. 20644, U.S.N.M. BELLA-BELLA, B. C. COLLECTED BY JAMES G. SWAN. 3, FIRE-MAKING SET AND SLOW MATCH. CAT. NO. 127866, U.S.N.M. QUINAIELT INDIANS, QUINAIELT, WASH. COLLECTED BY CHARLES WILLOUGHBY

purpose of the Sitkan, and in his skillful hands would no doubt give the spark in a minute or so. The long drill would indicate that two worked at it consecutively to keep up a continuous motion.

For tinder, the bark of the arbor vitae was used. It is finely frayed, and is much improved by being slightly charred. They also use, preferably, a tinder made from a fungus, because it is "quicker," that is, ignites more readily than the frayed bark.

The hearth is squared and measures 23 inches; the drill is of equal length.

The southern Tlingit drill in the American Museum of Natural History, New York City, has the hearth and drill of equal length. The hearth is a block having the head of a raven at one end and of a bear at the other. The drill is enlarged at the lower end, and the hearth has three fire holes. (Pl. 1, Cat. No. 239100, Alaska; Amer. Mus. Nat. Hist., N. Y.; hearth, 15 inches long (38 cm.); drill, 15.3 inches long (39 cm.).)

Going southward from Sitka the next fire-making set in the series is from Bella-Bella, British Columbia. These Indians are of the Salishan stock, and are called Bilhulas. The horizontal is a piece of cedar wood dressed square on three faces. It is apparently a piece of an oar or spear handle. The fire holes are shallow, and the fire slots are quite narrow. (Fig. 2.) The drills have been scored longitudinally near the rubbing end; this may be a device to cause the wood to wear away more rapidly and furnish fuel to the incipient fire. Fire has evidently been made with this set. Both parts are 1½ feet long; the drill is much thinner than that of Sitka. The tinder is a braided length of frayed cedar bark.

From a southern family of the Salishan stock, called the Quinaielt Indians, of Washington, the Museum has a complete set collected by the late Charles Willoughby. It consists of a hearth, two drills, and a slow match. The hearth is a rounded piece of cedar wood; opposite the fire holes it is dressed flat, so as to rest firmly on the ground. There are three fire holes with wide notches. The drills taper to each end; that is, are larger in the middle. (Fig. 3.) The powder, a fine brown dust, collects at the junction of the slot and fire hole, and there readily ignites. This side of the hearth is semidecayed. No doubt the slots were cut in that side for the purpose of utilizing this quality. The drills are bulged toward the middle, thereby rendering it possible to give great pressure and at the same time rapid rotation without allowing the hands to slip down too rapidly, a fault in many fire drills. The slow match is of frayed cedar bark, about a yard long, folded squarely together, and used section by section. Mr. Willoughby says:

> The stick with three cavities was placed upon the ground, the Indian kneeling and placing a knee upon each end. He placed one end of the smaller stick in one

FIG. 4.—FIRE-MAKING SET. CAT. NO. 24096, U.S.N.M. KLAMATH INDIANS, OREGON. COLLECTED BY L. S. DYAR.

of the cavities, and, holding the other end between the palms of his hands, kept up a rapid half-rotary motion, causing an amount of friction sufficient to produce fire. With this he lighted the end of the braided slow match of cedar bark. This was often carried for weeks thus ignited and held carefully beneath the blanket to protect it from wind and rain.

Fire is easily procured with this set. It takes but a slight effort to cause a wreath of aromatic smoke to curl up, and the friction easily grinds off a dark powder, which collects between the edges of the slot. When this ignites it drops down the slot in a little pellet, and falls upon the tinder placed below to receive it. Both drill and hearth are 18 inches long.

The Klamaths, of Oregon, of the Lutuamian stock, use a fire apparatus that looks very much like that of the Utes. The hearth is a rounded piece of softwood thinned down at the ends. (Fig. 4.) The drill is a long, round arrow stick, with a hardwood point set in with resin and served with sinew. (See Ute drill, fig. 7). The holes in this hearth are very small, being less than three-eighths of an inch in diameter. They are in the center, and the fire slot being cut into the rounded edge widens out below, so that the coal can drop down and get draught. The wood is quite soft, apparently being sapwood of yew or cedar, while the drill point is of the hardest wood obtainable. It is probable that sand is used on the drill. The hearth is 13 inches long, and the drill 26.

The Chinooks, a tribe of Indians of a separate stock, called Chinookan, formerly lived about the mouth of the Columbia River, in Oregon, but are now nearly extinct. James G. Swan, the veteran explorer, investigator, and collector among the northwest coast tribes, says that the Chinooks are the best wet-weather fire makers he ever knew.[4]

> To kindle a fire the Chinook twirls rapidly between the palms a cedar stick, the point of which is pressed into a small hollow in a flat piece of the same material, the sparks falling on finely frayed bark. Sticks are commonly carried for the purpose, improving with use.[5]

Paul Kane[6] describes the hearth as a "flat piece of dry cedar, in which a small hollow is cut with a channel for the ignited charcoal to run over. In a short time sparks begin to fall through the channel upon

[4] Northwest Coast, p. 248.

[5] Bancroft. Native Races, vol. 1, p. 237.

[6] Wanderings of an Artist Among the Indians. London, 1859.

finely frayed cedar bark placed underneath, which they soon ignite." The Ahts and Haidas also use cedar fire sticks of the usual Indian kind.

The Hupa Indians of California are of the Athapascan stock. Their fire drill is a carefully made piece of apparatus. (Fig. 5.) The hearth is of a reddish, punky piece, made from the roots of a willow (*Salix laevigata*), or of cottonwood roots (*Populus trichocarpus*). The drill is made from the root of the willow mentioned. Fire has been made in one of the holes; the others show the rough, frayed cavities which have been made to start the drill. The notches at each end of the hearth seem to be to facilitate the tying of the pieces together as a precaution to prevent their loss or separation. They are usually intrusted into the hands of the most skillful fire maker, who wraps them up to keep them from becoming damp. The effectiveness of the sticks increases with use and age; a stick and hearth that have been charred by the former making of fire in most cases yields the spark in half the time required for new apparatus. Another advantage is that the drill is softer from incipient decay.

That this set is in the highest degree efficient is shown by the fact that the writer repeatedly got a glowing coal, the size of a pea, from it in less than 20 seconds. The hearth is 18 and the drill 21 inches long.

The Nokum Indians of Lassen County, Calif., use a small hearth with wedge shape end, probably to steady the piece against a support while making fire. Small block hearths like this are customary among the Ute tribes. The drill is a slender rod worked from cedar, as is the hearth. (Cat. No. 131078; Susanville, Calif., L. L. Frost; hearth, 7 inches long (18 cm.); drill, 11 inches long (28 cm.).)

The McCloud River Indians (Copehan stock) make the drill from the buckeye tree.

The Indians of Washoe, Nev., from their language, have been classed by the Bureau of Ethnology as a separate stock, the Washoan. Stephen Powers many years ago collected a rather remarkable hearth from these Indians. It has eight rather small holes, in every one of which fire has been made. The wood is soft, well-seasoned pine. Apparently sand has been made use of to get greater friction, as is the

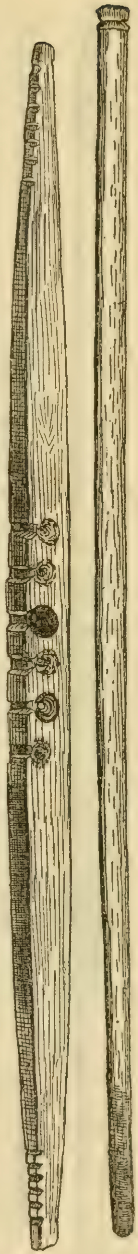


FIG. 5.— FIRE-MAKING SET. CAT. NO. 77193, U. S. N. M. HUPA INDIANS. CALIFORNIA. COLLECTED BY LIEUT. P H. RAY

custom of the Zuñis and Apaches. This device, in a measure, obviates the necessity of having tinderlike wood, or wood in a state of partial decay. For the drill any hardwood cylindrical stick might be employed. A strip of buckskin about an inch wide is passed around the hearth over the fireholes to keep them dry. (Fig. 6.)

At the end of the hearth is a mass of cement made of the resin of a pine mixed with sand, apparently, a kind of material used by the Indians over a large area in the Great Basin and southward to fix their arrowheads, pitch the water bottles, and for other purposes. It is quite probable that this stick was the property of an arrow maker whose need of fire to melt the somewhat intractable cement caused him to combine these functions in one tool.

It has a better finish and displays greater skill in its manufacture than the fire tools of the neighboring tribes of Shoshonian (Utes) and Moquelumnian stocks. In fact, it has a close affinity in appearance to those of the very near Athapascan (Hupa, etc.) stock. It is a matter of very great interest to compare with this a stick from the Mackenzie River. (See fig. 26.) The resemblance is striking; it is as though one found a word of familiar sound and import in an unexpected place. The related tribes of the Indians dwelling on the Mackenzie have a wider range than the distance between the localities whence the respective sticks came; in fact, the Athapascans range about 50° in latitude and the southern colonies of this great family are only about 250 miles southeast of the Washoans, while, as has been stated, the Hupas are quite near.

It would be presumptuous to say at present that this tool is a remnant of the influence of the Athapascan wave that swept along the Great Interior Basin, leaving groups here and there in California and other parts to mark its progress, but there is more to its credit than a coincidence of form and function.

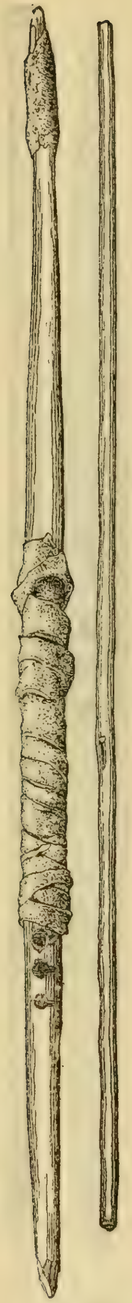


Fig. 6.—Fire-making set. Cat. No. 19640. U.S.N.M. Washoe Indians, Nevada. Collected by Stephen Powers

The museum is in possession of a complete collection of fire-making material from the tribes of the Shoshonian stock. They were collected by Maj. J. W. Powell. The native name for the Ute fire set is *whu-tu ni-weap*. While the lower member of the set—the

hearth—differs among the several tribes in point of material, shape, etc., the spliced drill is characteristic of the whole stock. It has never been noticed outside of the southern part of the Great Interior Basin but in one instance—among the Klamaths of Oregon. The main part of the drill is either a reed or a straight sprout, usually the former. At one end a short piece of very hard wood—greasewood, *Sarcobatus vermiculatus*—is set in and lashed with sinew. It resembles the Shoshonian arrows, which are foreshafted in this way. They also use sand in common with other neighboring tribes.

The Pai-Utes, of southern Utah, make their hearths of a short, rounded piece, usually of the sapwood of juniper. It is tied to the drill with a thong of buckskin when not in use. (Fig. 7.) The drill is like the usual one, just described. This is the common form of the Pai-Ute apparatus. The small, two-holed hearth of rounded form and the shortened, spliced drill are for convenience of carrying, this kind being used by hunters while away from the lodges. S. J. Hare says that the men do not usually make the fire except when out on a hunting excursion. At the lodge it is the squaw's duty to make the fire when it is needed.

The Pai-Ute is rarely at a loss to get fire; he is master of various devices. Mr. Hare, who was among the Utes for some time, states that when the Indian is in need of a light he uses either the flint and steel, the drill, or, if these are not at hand, he takes two branches and rubs one up and down on the other, soon getting fire. The Australians are said to have practiced fire making by rubbing in the way mentioned. This is the only observation collected of its occurrence in America. It is, in all probability, a difficult, unusual way, only practiced under pressure of necessity among the Utes. They take great pride in their skill; to be a quick fire maker is to achieve fame in the tribe. They are fond of exhibiting their art to white travelers in the hope of gain.

Another form of hearth (fig. 8) is made of yucca flower stalk, like those of the Apaches and Navaho. The drill is of tule reed, set with a very hard wood

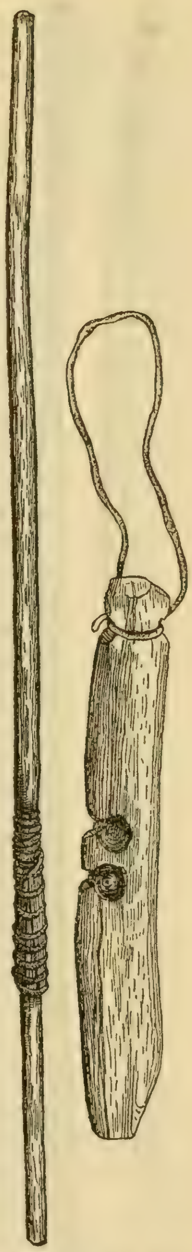


FIG. 7.—FIRE-MAKING SET. CAT. NO. 17230, U.S.N.M. PAI-UTE INDIANS, SOUTHERN UTAH. COLLECTED BY J. W. POWELL

FIG. 8.—FIRE-MAKING SET. CAT. NO. 11976, U.S.N.M. PAI-UTE INDIANS. SOUTHERN UTAH. COLLECTED BY J. W. POWELL

head. It is suggested that the reason for splicing the drill is that the hardwood of the kind used for the head (grease-wood) can not be procured in pieces long enough to make the whole drill. This set is apparently one used as a fixture in the Ute domestic economy, the squaws having to light the fire. The duty is mainly relegated to the females in several other Indian tribes and among the Eskimo. Mr. Catlin says that the Sioux objected to letting the squaws have their portraits painted, saying that their women had never taken scalps nor done anything better than make fires and dress skins.[7] The hearth and drill last figured are, respectively, 20 and 23 inches long, while in the hunting set (fig. 8) the length is 7 and 18 inches.

The Wind River Shoshones are also represented. (Fig. 9.) The hearth is of hardwood, rudely hacked out and rounded. Upon the slanting edge are eight holes or shallow depressions, prepared for the drill, with notches cut in to meet them from the sides. The drill is a willow branch, 25 inches long, with a hardwood head mortised in, and served with buckskin. It is most probable that sand was used with this set, because, if the parts are not models, it would be necessary to use it on sticks of equal hardness like these. I am inclined to believe that they are models, from their appearance and from the difficulty of setting up a pyrogenic friction upon them even with sand. They were collected more than 50 years ago by Maj. J. W. Powell.

The Hopi are the most differentiated members of the Shoshonian stock. Mrs. M. C. Stevenson collected the two excellent fire-making sets in the Museum from the Hopi Pueblos. The hearth is a branch of the very best quality of softwood (cottonwood). In one hearth an end has been broken off, but there still remain 18 fire holes, showing that it was in use for a long time and highly prized. (Fig. 10.) The drill is a roughly dressed branch of hardwood. It is comparatively easy to make fire on this apparatus. In the set numbered 126694 these conditions are reversed; the hearth is tolerably hard wood and the drill soft wood.

The Hopi fire tools are used now principally in the estufas to light the sacred fire and the new fire

[7] Smithsonian Report, 1885, pt. 2. p. 723.

as do the Zuñis, and the Aztecs of Mexico did hundreds of years ago. They use tinder of fungus or dried grass rubbed between the hands.

By their language the Zuñi people belong to a distinct stock of Indians. Their fire sticks are of the agave stalk, a soft, pithy wood with harder longitudinal fibers, rendering it a good medium for the purpose of making fire. (Fig. 11.)

As to the plan pursued in grinding out fire, Col. James Stevenson informed the writer that they make a slightly concave place where the burnt holes are seen, cut the notch on the side, sprinkle a little fine sand on the concavity, set the end of the round stick on the sand and roll it rapidly between the palms of the hands, pressing down hard. The "sawdust," Colonel Stevenson called it, oozes out of the notch and forms a small mass, which on blowing slightly becomes a burning coal, and the application of a little tinder creates a blaze. For preserving the fire for any length of time they use a piece of decayed wood. (Fig. 12.)

Fig. 9.—Fire-making Set. Cat. No. 22022, U.S.N.M. Shoshone Indians, Wind River, Wyoming. Collected by J. W. Powell

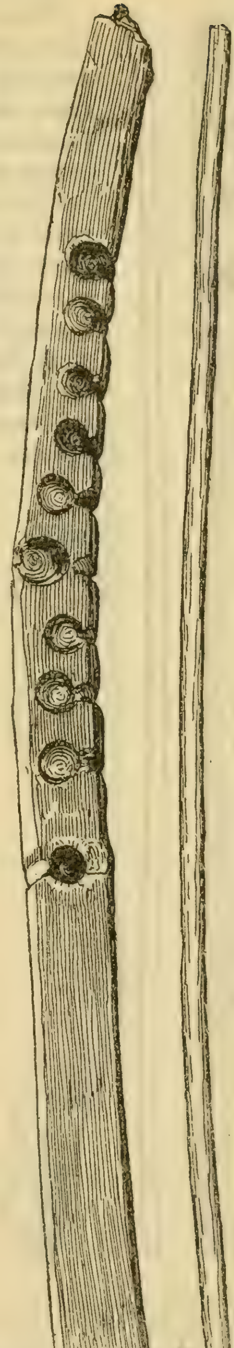


Fig. 10.—Fire-making set. Cat. No. 128694, U.S.N.M. Hopi Indians, Arizona. Collected by Mrs. M. C. Stevenson

Viewed in another aspect than as an implement of necessary or common use, this set is an important cult apparatus in the wonderfully complicated religious worship of the Zuñis. These people make the sacred fire that was used in their ceremonies by friction of wood that has been wet. New fire is made at the beginning of their new year with great ceremony. The house is swept and everything is moved out of it until the fire is made. Their regard for fire and their customs with reference to it add them to the list of peoples who have held it in similar reverence and have practiced similar customs all over the world, ranging widely in time. The wetting of the drill, increasing their labor, may be done to please their gods.

FIGS. 11 AND 12.—FIRE-MAKING SET AND SLOW MATCH. CAT. NOS. 127708 AND 69850 U.S.N.M. ZUÑI INDIANS, NEW MEXICO. COLLECTED BY JAMES STEVENSON

This art must have been practiced for a long time in this region, for Henry Metcalf found a hearth (fig. 13) with three fire holes in a cave dwelling at Silver City, N. Mex. It is apparently very ancient. The wood is much altered and has become heavy by impregnation with some salt, probably niter. Specimens are found during nearly every exploration in the cliff dwellings. They show entire uniformity in all parts of the region.

FIG. 13.—LOWER STICK OF FIRE-MAKING SET. CAT. NO. 35268, U.S.N.M. FROM A CAVE AT SILVER CITY, N. MEX. COLLECTED BY HENRY METCALF

The Apache and Navaho belong to the great Athapascan stock, that ranges so widely in North America. Capt. John G. Bourke, United States Army, collected the hearth of yucca wood shown (fig. 14), and says:

> With the stick you now see, the Apache Indians in my presence made fire in not quite eight seconds by the watch, and one asserted that he could make

it in a number of motions, which, on the watch, occupied exactly two seconds—that is, under most favorable circumstances. The experiments, made under my own observation, ran all the way from 8 to 47 seconds. Sand is generally used, although not essential to success.

Captain Bourke's observation is very interesting, as it records the fact that the Apache is the most skillful fire maker in the world. Many other tribes can make fire in less than a minute, I think by far the majority of them, but there is no eight-second record, while if he could prove his ability to do it in two seconds he would arrive at the facility of striking a match.

William F. Corbusier has noticed the fire making of the Apache-Yumas of Arizona (Yuman stock).[8] They use a drill about 2 feet long and one-half inch thick, made of o-oh-kad-je, or "fire-stick bush." Its end is dipped in sand and drilled on a soft piece of agave or yucca stalk held down by the feet. They carry a slow torch of deadwood (spunk) and also use a flint and steel. For tinder they use dry grass or bark fiber. They use also a fungus, some species of *Polyporus*), for the same purpose.

Another reference to the fire making of this stock (Yuman) is found in the translation by the late Dr. Charles Rau of the writings of Father Baegert on the Californian Peninsula.[9] He says:

> To light a fire, the Californian makes no use of steel and flint, but obtains it by the friction of two pieces of wood. One of them is cylindrical and pointed at one end, which fits into a round cavity in the other, and by turning the cylindrical piece with great rapidity between their hands, like a twirling stick, they succeed in igniting the lower piece if they continue the process for a sufficient length of time.

The Navaho fire set looks very much like a mere makeshift. The hearth is a piece of yucca stalk and the fire holes have but a shallow side notch. The drill is a broken arrow shaft, to which has been rudely lashed with a cotton rag a smaller piece of yucca wood. (Fig. 15.) This carelessness, which it is rather than lack of skill, is characteristic of the Navaho in their minor implements. They resemble the crude Apache in this

FIG. 14.—LOWER PIECE OF FIRE-MAKING SET. CAT. NO. 130679, U.S.N.M APACHE INDIANS, ARIZONA. COLLECTED BY CAPT. JOHN G. BOURKE U. S. ARMY

[8] American Antiquarian. Mendon, Ill., vol. 8, September, 1886, p. 283.
[9] Smithsonian Report, 1865, p. 367.

FIG. 15.—FIRE-MAKING SET. CAT. NO. 9555, U.S.N.M. NAVAHO INDIANS, NEW MEXICO. COLLECTED BY EDWARD PALMER

One thinks of the Navaho only with regard to their fine blanket weaving and silver working, so well presented by Dr. Washington Matthews in the reports of the Bureau of Ethnology, and does not consider their arts in other lines.[10]

Thomas C. Battey, a Friend, long missionary among the Indians, kindly gives a description of the Kiowan fire-making process, not now practiced among them but shown to him as a relic of an abandoned art:

A piece of very hard and coarse, rough-grained wood, perhaps 8 inches in length, 2 in width, and three-fourths of an inch in thickness is procured. In one side of this and near one edge several holes are made, about one-half an inch in diameter by five-eighths of an inch in depth, rounded at the bottom, but left somewhat rough or very slightly corrugated. In the edge nearest these holes a corresponding number of smaller and tapering holes are made, opening by a small orifice into the bottom of each of the larger ones. These are made very smooth.

A straight stick, also of hard, rough-grained wood, about 8 or 10 inches in length, about the size they usually make their arrows or larger, is provided. Both ends of this are rounded, but one end is made smooth; the other is left slightly rough. The dried pith of some kind of reed, or more probably of the yucca, some fibers of the same loosely prepared like hackled flax, some powdered charcoal, I think formed by charring the yucca, and a piece of hard, thick leather, similar to sole leather, completes the outfit, which is carried in a leather bag made for the purpose. The first-described piece of wood is placed upon the knees of the operator with a quantity of the fibrous substance beneath it which has been powdered with charcoal dust; some of the latter is put into one of the holes and the rough end of the stick inserted; the other end is put into an indentation of the leather placed under the chin, so that a gentle pressure may be exerted. The spindle is then rapidly revolved by rolling it one way and the other between the hands. The friction thus produced by the rubbing of the roughened surfaces ignites the fine coal dust, which, dropping as sparks of fire through the orifice at the bottom of the hole, falls into the dry fibrous preparation, thus igniting that, then by the breath blowing upon it a flame is produced and communicated to some fine, dry wood and a fire is obtained. The whole operation occupies but a few minutes.

In Mexico a number of the uncivilized tribes of the mountains continued the fire drill into recent times. It is probably used now as in other parts

[10] Doctor Matthews's mountain chant of the Navahos, in the fifth annual report (1883-84) of the Bureau of Ethnology, gives some very striking ceremonial uses of fire. No ethnologist should fail to read this important contribution to science.

of the world in religious rites. There is abundant data in the pictorial writings of the ancient Mexicans as to the form and use of the simple fire drill, especially in the codex discovered by Mrs. Zelia Nuttall. A model of a drill after this codex is shown on Plate 2, figure 2*a*.

One of the rudest fire-making appliances in the Museum was collected by Prof. W. M. Gabb, at Talamanca, Costa Rica. The hearth is a rude billet of charred, black wood, resembling mahogany. It has central holes, with no gutter usually, though sometimes a shallow notch is cut on both sides of the fire-hole. The drill is a light branch, rather crooked, but dressed down roughly with a knife. Another hearth is of partly decayed, worm-eaten wood; with this a hardwood drill can be used, the hearth wasting away instead of the drill. (Fig. 16.) The absence of any fire slot—that is, the use of the central fire hole—is worthy of notice in this locality. I have only observed its use in various parts of the Eskimo area, from east Greenland to Kodiak; outside of this range I have not noticed it anywhere else among the present tribes of the world. From descriptions given it seems to have been practiced by the Caranchua Indians, a recently extinct tribe in Texas and Mexico.

These specimens from Costa Rica are the crudest fire tools, not to be mere makeshifts, that have come to my notice or have been described in the literature examined. The Costa Rican Indians are very interesting in their preservation of several other arts that may justly be classed among the most ancient. One may be mentioned, that of bark cloth making.

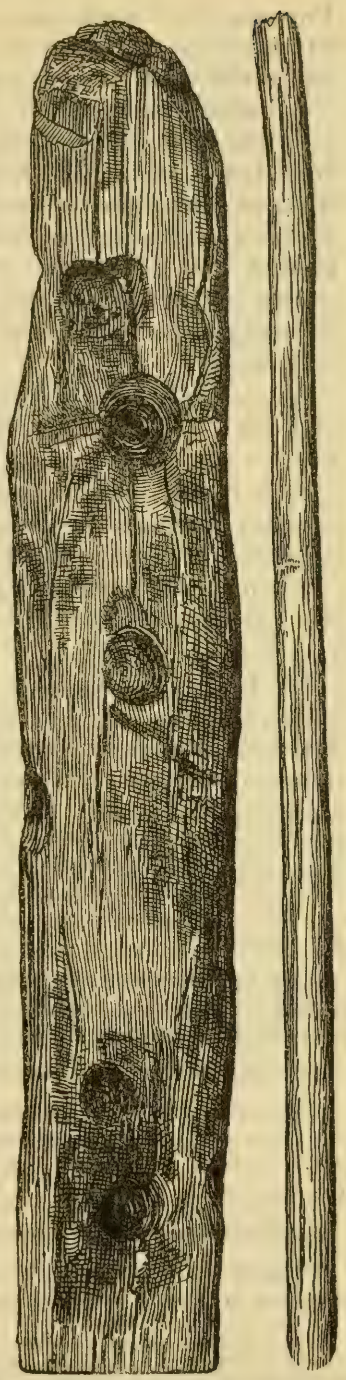


FIG. 16.—FIRE-MAKING SET. CAT. NO. 15396, U.S.N.M. NATIVES OF TALAMANCA, COSTA RICA. COLLECTED BY W. M. GABB

Professor Gabb made quite a collection from Talamanca, but has not left any notes on these remarkable people, who are well worthy of the careful study of ethnologists.

A curious modification of this central-hole plan is figured and described in Oviedo, folio 90, as occurring in Hispaniola—that is, the West Indies, Haiti, San Domingo, etc. He says that "two dry, light sticks of brown wood were tied firmly together, and the point of the drill of a particular hardwood was inserted between the two and then worked." H. Ling Roth [11] thinks that if one can judge from the illustration (which is a miserable one) in Benzoni's work, the natives of Nicaragua also used three sticks in making fire. Benzoni, however, says: [12]

> All over India they light fire with two pieces of wood; although they had a great deal of wax, they knew no use for it, and produced light from pieces of wild pine wood.

From Oviedo's description I am inclined to believe that the dust in which the fire starts was allowed to fall below on tinder placed beneath the hearth. (Pl. 2, fig. 2.)

The drill was sufficient for its time for the reason that there was at that period rarely necessity for generating fire; the art of fire preservation was at its height.

The Cherokees, the most southerly of the Iroquois, James Mooney writes, kept fire buried in the mounds upon which the council houses were built, so that if the house was destroyed by enemies the fire would remain there for a year or so. The Cherokees use the simple rotation apparatus, and, as far as Mr. Mooney can ascertain, never used the the pump drill. They have a tradition that fire originally came out of an old hollow sycamore tree (*Platanus occidentalis*).

Capt. John Smith tells how the Indians of Virginia made fire. He says:

> Their fire they kindled presently by chafing a dry pointed sticke in a hole of a little square piece of wood, that firing itselfe, will so fire mosse, leaves, or anie such like drie thing that will quickly burn.[13]

Writing in the first quarter of the next century, Beverley says:

> They rubbed Fire out of particular sorts of Wood (as the Ancients did out of the Ivy and Bays) by turning the end of a Piece that is soft and dry, like a Spindle on its Inke, by which it heats and at length burns; to this they put sometimes also rotten Wood and dry leaves to hasten the Work.[14]

Loskiel says of the Delawares:

> Formerly they kindled fire by turning or twirling a dry stick with great swiftness on a dry board, using both hands.[15]

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[11] The Aborigines of Hispaniola, Journ. Anthrop. Inst., Gt. Britain and Ireland, vol. 16, p. 282.

[12] History of the New World, Hakluyt Society, vol. 21, p. 151.

[13] The Natural Inhabitants of Virginia. English Scholars Library, No. 16, p. 68.

[14] History of Virginia, 1722, pp. 197, 198.

[15] History of the Mission of the United Brethren, p. 54. London, 1794.

The Cherokees used for a drill the stalk of a composite plant (Senecio) and twirled it on a piece of wood. The art has long been out of common use, but they employed the wooden drill to make fire for the Green Corn Dance into the present century, though flint and steel was then in vogue. Sometimes they passed the bow over the drill. The tinder was of a fungus or dried moss. James Mooney collected this information from some of the older men of the tribe in North Carolina, who have retained the ancient customs and traditions, which the part of the tribe removed to the West has entirely lost.

The Creeks (Muskogean stock) had a regularly authorized fire maker who early in the morning made fire for the Green Corn Dance. The apparatus that he made use of was four sticks placed end to end to form a square cross. This was oriented, and at the junction of the sticks new fire was made by friction.[16]

The Choctaws (also Muskogean) of Mississippi, M. F. Berry writes, make fire in the following way: One stick of dry wood that has a hole in it, with a smaller hole at the bottom going through, is placed between the feet. Another piece made round and about 3 feet long is made to revolve rapidly back and forth between the hands in the hole, and the fire drops through the small hole below. When new fire was wanted for the Green Corn Dance or other purposes three men would place themselves so that each in turn could keep the stick revolving without a stop until fire would drop down through the hole, which was nursed with dry material into a flame.

This form of the fire hearth is not represented in the collections of the Museum; the only other description of a process closely like it was given by Thomas C. Battey, who observed it among the Kiowas. It was shown him at that time as a revival of the ancient method. The pierced fire hearth is somewhat impracticable, except in the Malay sawing method. In the rotary drill the small hole would come over the axis of least friction and heat. Unless provision was made for the dust to fall freely underneath by a double cone perforation worked from both sides the dust is likely to become obstructed and smother the fire. It will be seen, too, that it departs very much from the simplicity of the usual fire drill in the fact that a hole must be made through the piece of wood, a matter of some difficulty before the introduction of iron awls.

The Seminoles of Florida, the most southern Muskoki, have neglected the art of fire making by simple friction, unless at the starting of the sacred fire for the Green Corn Dance, says Clay MacCauley.[17] A fire is now kindled either by the common matches, *ma-tci*, or by steel and flint.

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[16] Benjamin Hawkins' Sketch of the Creek Country, 1798-99, pp. 68-72, cited in Pickett's History of Alabama, vol. 1, p. 108.

[17] Fifth Annual Report of the Bureau of Ethnology for 1883-84, p. 513.

Thus it is seen that wherever in the earlier period of the exploration in this country the observation has been made, the Indian, almost with out exception, was found to be using the friction apparatus consisting of two sticks of wood. Some tribes had improved on the working of the invention, while a very few others had perhaps arrived at the use of the higher invention of the flint and pyrites.

Returning to the tribes of the wide central plains of our country, we find that the flint and steel soon displaced the fire sticks, except for religious purposes. The Mandans, of the great Siouan stock, were using flint and steel at the time of Mr. Catlin's visit in 1832.[18]

There seems to be a great misapprehension among some of the writers on ethnology as to the general use of the bow drill among the Indians. In mentioning that the Sioux use the bow drill, Schoolcraft is quoted as authority. As a matter of fact the reference is to a "made-up" figure of a bow-drill set, marked "Dacota." On the same plate there is a representation of an Iroquois pump drill that is obviously wrong. The lower part of the plate is taken up by a picture of an Indian woman (presumably Californian) pounding acorns in a mortar. To complete the absurdity the whole plate is entitled "Methods of obtaining fire by percussion," and is placed in the text of a questionnaire on the Californian Indians, opposite a description of the Californian way of making fire by twirling two sticks.[19]

Mr. Schoolcraft is not to blame for this state of affairs. In those days illustrations were not ethnological; they were "padding" gotten up by the artist. Nowhere in his great work does Mr. Schoolcraft describe either the Dakota or Iroquois drill. Among the northern Indians in central and northern Canada, however, the bow is used.

Sir Daniel Wilson, in his work on Prehistoric Man, notes that the Red Indians of Canada use the drill bow. In August, 1888, at the meeting of the American Association for the Advancement of Science, at Toronto, he gave an account of the facility with which these Indians make fire. He said that at Nipissing, on the north shore of Lake Superior, while he was traveling in a pouring rain, and not having the means wherewith to light a fire, an Indian volunteered to light one. He searched around for a pine knot and for tinder, rubbed up the soft inner bark of the birch between the hands, got a stick from a sheltered place, made a socket in the knot and another piece of wood for a rest for the drill, tied a thong to a piece of a branch for a bow. He put the tinder in the hole and rested his breast on the drill and revolved it with the bow and quickly made fire.

[18] The George Catlin Indian Gallery. Smithsonian Report for 1885, vol. 2, p. 456.

[19] Indian Tribes, vol. 3, pl. 28. 1851–1860.

It is perhaps true that some of the Dakotas did use the bow at times, but it is not correct to place it as the customary tool of the whole stock. On the contrary, there is evidence that they used the simple means. Dr. J. Owen Dorsey writes:

I was told in 1879 by the late Joseph La Flèche, that the Omahas, prior to the advent of the white men, made fire by using pieces of the "du-à-du-á-hi," a grass (?) that grows in the Sand Hill region of Nebraska, near the sources of the Elkhorn River. One piece was placed horizontally on the ground, and a slight notch was cut at one end, wherein a few grains of sand were put. The other stick was held between the palms of the hands, with one end in the notch of the horizontal stick, and then rolled first in one direction then in the other till fire was produced. A fresh notch was made in the first stick whenever the old one became useless, and so on until it became necessary to procure a new stick.

In the Green Corn Dance of the Minitaries, another Siouan tribe, the "corn is boiled on the fire, which is then put out by removing it with the ashes and burying them. New fire is made by desperate and painful exertion, by three men seated on the ground facing each other and violently drilling the end of a stick into a hard block of wood by rolling it between the hands, each one catching it in turn from the others without allowing the motion to stop until smoke, and at last a spark of fire is seen and caught in a piece of spunk, when there is great rejoicing in the crowd." [20] The desperate exertion was not necessary, except in imitation of the Zuñi fashion of wetting the drill to create sacred fire.

It will be seen from these references given that the Sioux used the customary Indian method. Later, they may have used the bow to expedite the drill when the wood was intractable. The bow may have been borrowed from more northern tribes, the Algonquians are said to used it; [21] Thomas C. Battey says that the Sac-Fox Indians (Algonquian stock) used a soft-wood drill and a hard-wood hearth. "The drill was worked by a bow and the fire caught on the end of the drill and touched to tinder."

Throughout South America the art of fire making with two sticks of wood is found to be as thoroughly diffused as it is in North America. Many of the tribes still use it; we may say that in all tribes the use of flint and steel was preceded by that of the sticks of wood.

From Carib-Arawak tribes of British Guiana come simple jungle-fire drills consisting of peeled and dressed rods of soft-yellow wood. A bit of the black bark is left at the upper end of the drill as an ornament. The hearth has a fire pit near the end or in the smaller hearths near the middle. (Pl. 2, figs. 1, 1*a*, Cat. No. 210445, British Guiana, coll. by J. J. Quelch, received from the Field Museum of

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[20] Smithsonian Report, vol. 2, p. 315, 1885.
[21] Sir Daniel Wilson. Prehistoric Man, vol. 2, p. 375.

Natural History, Chicago; drills 15–19 inches long (38–48.3 cm.); hearths 5.5–7 inches long (14–17.7 cm.).)

The Guanchos, a mixed tribe of herders on the pampas of Venezuela, practice a peculiar way of fire getting. They select a pliant rod, place one end against the breast and the other against the block forming the hearth, held on a line with the breast. By pressing against the rod it is bent and turned rapidly around like an auger. This impracticable and no doubt very local method is described by Prof. E. B. Tylor.[22]

In Brazil, in the province of Goyaz, the Chavantes, Cayapós, and Angaytés, use the simple fire drill.[23] The Angaytés drill figured looks somewhat like that of the Hopis. It is usually 28 cm. long for the hearth, and for the drill 20 cm. They use the throat skin of the nandu, *Rhea americana*, for a tinder sack. The Lenguas of the same Province use a strike-a-light consisting of a tinder horn, flint, and steel, which is also figured in the cited report. This set is very interesting, because from it we can say with certainty where the Lengua got it. The steel is the English "flourish" and the flint is the oval, old English shape, probably broken somewhat by blows. The Lenguas, being on the line of travel, have adopted the method from English traders. In Rio de Janeiro the Indians had an angular recess at the back of their snuff mills for the purpose of making fire by friction.[24]

The Ainos of Japan formerly used fire sticks, and are said even yet to resort to this method when they have no other means of getting fire. They use also flint and steel, adopted from the Japanese. A specimen (22257) is in the Collections of the Museum.

The Japanese formerly used the simple drill; a few are yet preserved and used in the temples on special occasions. A specimen is exhibited in the Imperial Museum at Tokio. Several years ago Mr. Stewart Culin, after difficult negotiations through Mr. Tsuda of the Tokio Museum, secured a specimen for the Smithsonian Institution from Baron Menge of the Idzumo shrine. The specimen is like that in the Imperial Tokio Museum from the Oyashiro Temple at Idzumo. It is a smooth, most accurately dressed plank 35.5 inches long (90.5 cm.), 4.75 inches wide (12 cm.), and 1.2 inches thick (3 cm.), of *Chamaeocyparis obtusa* wood. There are 42 fire pits on the two edges, generally 1 inch between centers. The holes are drilled deeply and several calibers of drill have been used. The drill is a stem of *Deutzia scabra* with strong walls and large pith. In many of the holes a core is produced as in the tubular drill. This fire drill was used in the Harvest Festival. The inscription in well written characters is, in

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[22] Darwin. Narrative of the Voyage of the *Beagle*. Vol. 3, p. 458. Cited in Early History of Mankind, p. 241.

[23] Dr. Emil Hassler. In Jahrbuch Mittelschweiz. Commerciel. Gesellsch. Arau, 1888, vol. 2, pp. 114-115.

[24] Harper's Monthly Magazine, vol. 7, p. 745. November, 1853.

part, "fire cuts wood Meiji 35 years November 27," the probable date of the Harvest Festival of thanksgiving and production of new fire. (Pl. 3, Figs. 1, 2.)

In the Transactions of the Asiatic Society of Japan for 1876 (vol. 2, p. 223) a sacred fire hearth is described as having a step as observed in some Eskimo forms. This feature has been taken to be a usage required by the environment of the high north. In Japan, however, it may refer to the collecting and saving of the ground-off dust for healing or other esoteric purposes.

In reference to the use of the sacred fire drill, the following data have been supplied by Romyn Hitchcock:

> The fire drill is used at the festivals of the Oyashiro to produce fire for use in cooking the food offered to the gods. Until the temple was examined officially in 1872 the head priest used it for preparing his private meals at all times. Since then it has been used only at festivals and in the head priest's house on the eve of festivals, when he purifies himself for their celebration in the *Imbidous*, or room for preparing holy fire, where he makes the fire and prepares the food.

The art of fire making by sticks of wood by the method of rotation is, or has been, as far as we know, universal on the African Continent as it was in the two Americas at the time of the discovery. It is presumable that the ancient Egyptians who had the bow drill used this implement and previous to its invention used the simple drill.

The Somalis are a pastoral people of Arab extraction, inhabiting a large maritime country south of the Gulf of Aden. Their fire sticks (fig. 17) are pieces of branches of brownish wood of equal texture, in fact the hearth has formerly been used as a drill, as may be seen by its regularly formed and charred end. This is another proof that it is not necessary that the sticks should be of different degrees of hardness. The grain of the wood, that of the drill being against and the hearth with the grain, in effect accomplishes what the use of wood of different qualities results in. The hearth and drill are in the neighborhood of 12 inches long, the former with a diameter of three-eighths of an inch and the latter one-fourth of an inch. They were collected by Dr. Charles Pickering in 1843.

FIG. 17.—FIRE-MAKING SET. CAT. NO. 129971, U.S.N.M. SOMALIS, EAST AFRICA. COLLECTED BY DR. CHARLES PICKERING. LENT BY PEABODY MUSEUM THROUGH F. W. PUTNAM

It is possible that the Somalis may have carried this method with them from Arabia. They

conquered this coast, driving back the earlier tribes inhabiting the country in the early part of the fifteenth century. Long since that time, and even now, some Arab tribes practice the drilling of wooden sticks to produce fire.

In eastern equatorial Africa the Wataveita, says H. H. Johnston, generate fire in the common African way by rapidly drilling a hard-pointed stick into a small hole in a flat piece of wood. An interesting bit of custom comes out in connection with this art among the people. "It is the exclusive privilege of the men, and the secret is handed down from father to son, and never under any conditions (as they say) revealed to women." I asked one man why that was. "Oh," he said, "if women knew how to make fire they would become our masters."[25] The figure (fig. 18) shows how this people of the great Bantu stock make fire; this tribe visited by Mr. Johnston lives on the slopes of the beautiful Kilimanjaro Mountain.

FIG. 18.—TAVEITA AFRICANS MAKING FIRE. AFTER H. H. JOHNSTON. (SEE JOUR. SOC. ARTS, JUNE 24, 1887)

Fire-drill survivals in Asia are now difficult to find. In the ancient writings of India there are many references to the use of the two-stick apparatus. The collection contains a specimen from the Bhilis of the Rajputana, India. It consists of a hearth made from half of a split branch, while the drill is a slender shoot with bark left on. The specimen was collected by Captain Lovett, of the English Army. (Pl. 4, fig. 1, 1*a*, Cat. No. 167334; Edward Lovett; hearth, 18 inches long (45.7 cm.); drill, 20.5 inches long (51 cm.).)

There was presented to the United States National Museum by the Natural History Museum of Oxford, England, through Henry Balfour, a replica of a Hindu sacred fire making set. This consists of a squared

[25] Journ. Anthrop. Inst., Great Britain and Ireland, vol. 15, p. 10, 1885.

block of wood 2½ inches thick, a drill in the cutting end of which can be set a cylindrical piece of superior wood or bitt and another piece supplied when it is worn down, a supply of such pieces sawed in a block of wood, a nut to be held with two hands and having an inset of stone, and a cord for rotating the drill. These parts are named, respectively, "adhararani"; the lower, "arani"; "mantha," the spindle drill; "sauku," set or bitt; and "uttararani," wood for the bitt. In respect to remarks on the necessity of a slot for collecting the fire dust, it may be said that this drill is an exception, as it is found that a drill spindle of unusual diameter obviates the necessity of a slot, the tendency of the movement on a large periphery being to roll off masses of the dust which ignite at one or more places. (India, Cat. No. 150887, Natural History Museum, Oxford, England; length of spindle with bitt, 20 inches (51 cm.). (Pl. 5, figs. 1–4).) The elaborateness of this fire-making set is an example of the tendency to complexity in cult apparatus.

The turned drill and hand rest, the nut of iron, the iron pin, and bands on the drill naturally mark this set as modern in construction. This sacred fire drill is a model of the apparatus used in Brahmanic India by the fire priest, "agnihotrin," for the daily sacrifices of milk and butter according to the Vedic rituals. The apparatus is set up on an antelope skin.

Dr. W. L. Abbott brought from the Jakuns of the Endau River, Johore, a fire-drill set which, on account of the inaccessibility of these natives and the little known of them till lately, may be considered rare. The equipment as carried by the Jakuns consists of a bundle of little rods of about the same diameter, any one of which may be used as a drill or hearth at choice. There is no separation of hearth and drill. This feature is noticed also among the South American jungle tribes. It will be seen that in this case there is no need for a slot, as the working of the drill upon a hearth of equal caliber cuts a slot in the wall of the hearth automatically. (Cat. No. 213441; Dr. W. L. Abbott; 12–20 inches long (31–54 cm.).) Another bundle of fire sticks, native name, "kooshuk," from the Jakuns of the Rumpin River, Pahang, consists of rude rods, but having the same features mentioned in the Johore set except that the hearth pieces are slightly larger. (Cat. No. 219931; Dr. W. L. Abbott; hearth, 10 inches long (25 cm.); drill, 15 inches long (38 cm.).)

The Malays of the islands of Nias, Pagi, and Simalur, East Indies, have the cord drill. Dr. W. L. Abbott procured several sets from these islands described as follows:

The specimen from Sibabo Bay, Simalur Island, consists of a square piece of light yellow wood with used fire cavity in the middle, and adjoining a place with channel down the side of the block for a new working of the drill. The latter is a short, cylindrical, tapering

piece of the same wood. The cord is twisted brown fiber. The top of the drill is smoothed off by wear against the nut, which was a piece of coconut shell. This set is small and compact for carrying on the person. (Pl. 6, fig. 4, 4*a*, Cat. No. 216340; Dr. W. L. Abbott; 5.5 inches long (14 cm.).)

The apparatus from Pulo Simalur is larger than the set described above, and the drill is rotated with a strip of rattan. The wood is yellow, quite firm, and not hard. The hearth is squared and the drill is tapering as in the Pagi specimen. The native name of the fire set is "ludang." (Pl. 6, fig. 3, 3*a*, Cat. No. 221833; Dr. W. L. Abbott; hearth and drill 13 inches long (33 cm.).)

A general similarity with the Pagi and Simalur fire sticks is observed in the Nias specimens. It will be seen from the above that the fringe of islands off the south coast of Sumatra may be characterized as an area in which the cord drill is used. The specimens brought by Doctor Abbott have been chopped out of light-yellow wood, often showing worm holes. The cord is twisted brown bark. (Pl. 6, fig. 1, 1*a*, Cat. No. 221831, Lafau, Nias; Dr. W. L. Abbott; hearth, 15 inches long (38 cm.); drill, 11 inches (28 cm.).)

The north Pagi specimen is cut from very light wood, the hearth is squared and grooves cut in the regular way, and the drill appears to have been used in the hands. (Pl. 6, fig. 2, 2*a*. Cat. No. 221830; Dr. W. L. Abbott; drill, 10 inches (25.5 cm.); hearth 12 inches (30.5 cm.).)

Dr. Jesse R. Harris, United States Army, collected a fire hearth from the river district up the Rio Grande de Mindanao, P. I., presumably of Mandayan origin. Doctor Harris says: "The fire drill works with a bow and is a good one." The hearth is of soft worm-eaten wood and has three rather large cavities with slots. It is like the Malay drills of Simalur, Pagi, and Nias, and much extends the range of the machine drills in these regions. The native name is *Col-in-sung-an*. (Cat. No. 247525; 12 inches long (30.5 cm.).)

The Museum collection has a specimen from the Battaks of Palawan, P. I., which consists of a cleft stick held open at one end by a small stone and deeply sawed where fire has been made. The thong is of rattan one-eighth inch in diameter formed by spiral turns into a ring which is worn as a bracelet by the Battaks when it is not needed for fire making. (Pl. 9, fig. 2, Cat. No. 326012, collected by Mrs. E. Y. Miller.)

Mr. R. W. Felkin,[26] in a study of the Maidu or Moru negroes of Central Africa, 5° north latitude, 30° 20′ east longitude, describes the fire making of that tribe. He says that one piece of wood about the size and shape of a large pencil is rotated in a hole in a flat piece of hard wood. One man holds the wood steady whilst two others take

[26] Proc. Royal Soc. Edinburgh. Session of 1883–84, p. 309.

it in turn to rotate the stick. This article of Mr. Felkin's is commended to ethnologists as a model ethnologic study in method and research.

That veteran and renowned explorer, Doctor Schweinfurth, gives the following:

> The method of obtaining fire, practiced alike by the natives of the Nile lands and of the adjacent country in the Welle system, consists simply in rubbing together two hard sticks at right angles to one another till a spark is emitted. The hard twigs of the *Anona senegalensis* are usually selected for the purpose. Underneath them is placed either a stone or something upon which a little pile of embers has been laid; the friction of the upper piece of wood wears a hole in the lower, and soon a spark is caught by the ashes and is fanned into a flame with dry grass, which is swung to and fro to cause a draught, the whole proceeding being a marvel which might well nigh eclipse the magic of my lucifer matches.[27]

The Gaboon negro fire set is one of the few observed having no dust channel cut on the hearth. The wood, however, is light and apparently first class for fire making with least effort. It resembles the hibiscus wood used by the Hawaiians and other Polynesians, a most admirable material in which fire could be raised without the presence of the usual slot. The hearth is a peeled stem 1 inch in diameter, with large cavity midway. The drills are smaller stems pared down at the end, as is usual. (Pl. 7, Fig. 1, 1*a*, Cat. No. 164671; Gaboon River, West Africa; A. C. Good; hearth 23 inches long (58.5 cm.), drills, 21.5 and 24.5 inches long (55 cm. and 62 cm.).)

Dr. W. L. Abbott collected specimens from the Wa Chaga negroes, Mount Kilimanjaro, East Africa, years ago. The hearth is a small worked-out block carefully shaped or rough, as shown in the figures. The hearth has a cord at one end for tying to the drill for convenience in carrying. The drill is a straight, slender rod, with neatly cut hole at top for the hearth string. (Pl. 7, fig. 4, Cat. No. 161824, Dr. W. L. Abbott; drill, 20.5 inches long (52 cm.); hearth, 5 inches long (13 cm.).)

The use of worm-eaten wood is shown in the Wa Chaga hearth (pl. 7, fig. 2) and is evidence that wood is often conditioned for fire making by insects and fungi. Wa Chaga tinder is macerated bark. (Fig. 2*b*.) The drill is a peeled branch. (Fig. 2*a*, Cat. No. 151823.) Collected by Dr. W. L. Abbott in 1891.

The Somali drill is a workmanlike tool consisting of two smoothed rods of equal length, the drill hole at one end of the rod of larger diameter. It will be noticed that the cut of the drill opens the rod into two V-shape cuts, insuring the perfect collection of dust. The owner of the set pierced the two rods and drew through a slender leather thong to bind them together when not in use. (Pl. 7, Fig. 3;

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[27] The Heart of Africa, vol. 1, pp. 531, 532. New York, 1874.

Cat. No. 167094, Somalis, East Africa; William Astor Chanler; 24¼ inches long (61.5 cm.).)

It is an anomaly that the African, to light the fire to smelt the iron out of which he forges his remarkable weapons, should use sticks of wood.

An Australian fire set from New South Wales, collected in 1890 by William Villiers Brown, is an example of the careful manner with which the natives prepared and conserved their fire tools. The hearth is cut from soft, worm-eaten wood in a presumably human outline. Three sticks with vascular pith are tied to the hearth. The cut of such sticks leaves a core in the center of the drilled cavity. (Pl. 4, fig. 2, Cat. No. 168116; hearth, 14½ inches long, drills, 21 inches long.)

2. *Eskimo four-part apparatus.*—The arts of the Eskimo yield more satisfactory results to students of comparative ethnology than those of any other people.

In all their range the culture is uniform; one finds this fact forced upon his observation who has examined the series of specimens in the National Museum, where they are arranged in order by localities from Labrador to southern Alaska. Prof. Otis T. Mason's paper on Eskimo throwing sticks [28] gave a new interpretation to this fact and powerfully forwarded the study of ethnology by showing the classificatory value of the distribution of an art.

Professor Mason points out that though the Eskimo culture is uniform in general, in particular the arts show the modification wrought by surroundings and isolation—tribal individuality, it may be called—and admit of the arrangement of this people into a number of groups that have been subjected to these influences.

The Eskimo fire-making tools in the Museum admit of an ethnographic arrangement, but in this paper it is not found necessary to make a close study of this kind. From every locality whence the Museum possesses a complete typical set it has been figured and described.

The Eskimo are not singular in using a four-part apparatus, but are singular in the method of using it. The mouthpiece is the peculiar feature that is found nowhere else.

The drilling and fire-making set consists of four parts, as follows:

The mouthpiece, sometimes a mere block of wood, ivory, or even the simple concave vertebra of a fish or the astragalus of a caribou. More often, they show great skill and care in their workmanship, being carved with truth to resemble bear, seals, whales, and walrus. The seal is the most common subject. The upper part is almost always worked out into a block, forming a grip for the teeth. The extent to which some of these are chewed attests the power of the Eskimo jaw.

[28] Throwing sticks in the National Museum. Smithsonian Report, vol. 2, p. 279, 1884.

Frequently the piece is intended to be held in the hand, or in both hands, hence it has no teeth grip. In the under part is set a piece of stone, in which is hollowed out a cup-shaped cavity to hold the head of the drill. These stones seem to be selected as much for their appearance as for their antifriction qualities. They use beautifully mottled stone, marble, obsidian, and ringed concretions.

The drill is always a short spindle, thicker than any other drill in the world. It is frequently of the same kind of wood as the hearth.

The thong is the usual accompaniment of the fire drill. It is rawhide of seal or other animals. The handles have a primitive appearance; they are nearly always made of bears' teeth, hollow bones, or bits of wood. Sometimes handles are dispensed with. Warren K. Moorhead found some perforated teeth in an Ohio mound that in every respect resemble the Eskimo cord handles. They have also been found in caves in Europe decorated with concentric circles like those on the Eskimo specimens.

The bows are among the most striking specimens from this people. They are pared down with great waste from the tusks of the walrus, taking the graceful curve of the tusk. The Museum possesses one 24½ inches long. It is on their decoration that the Eskimo lavishes his utmost art. The bow does not lend itself well to sculpture as does the mouthpiece, so he covers the smooth ivory with the most graphic and truthful engravings of scenes in the active hunting life in the Arctic, or he tallies on it the pictures of the reindeer, whales, seals and other animals that he has killed.

Professor Baird was interested more with these bows than with any other Eskimo products, and desired to have them figured and studied.

The distribution of the bow is remarkable. It is not found south of Norton Sound, but extends north and east as far as the Eskimo range. The Chukchis use it,[29] but the Ostyaks use the ancient breast drill.[30]

The bow is used by individuals in boring holes. It is presumed that its use as a fire-making tool is secondary, the cord and handles being the older. The difficulty of making fire is greatly increased when one man attempts to make it with the compound drill; at the critical moment the dust will fail to ignite; besides, there is no need of one man making fire; a thing that is for the common good will be shared by all. Hence the cord with handles, which usually requires that two men should work at the drill, is as a rule used by the Eskimo.

Though the Sioux, and some other North American tribes, made use of the bow to increase the speed of the drill, they did not use the thong with handles, nor was the bow common even in tribes of the

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[29] Nordenskiöld. Voyage of the *Vega*, vol. 2, p. 121, London, 1881.
[30] Seebohm. Siberia in Asia, p. 109.

Siouan stock that had attained to its use. (See remarks, p. 25.) The bow may be termed a more advanced invention, allowing one man with ease to bore holes.

The hearth is made of any suitable wood. It is commonly stepped and has slots. The central hole with groove is also found. These hearths are preserved carefully, and fire has been made on some of them many times.

The distribution of the central-hole hearth (see fig. 19) and the slot-and-step hearth (see fig. 32) is rather striking. The central holes are found in the specimens observed from the north coast of Alaska, insular British America, and Greenland, exclusively. The stepped hearth with edge holes and slots is by far the more common in western Alaska, though the other method crops out occasionally; both ways are sometimes used in the same tribe. More often the central holes are bored on a groove (fig. 30), which collects the ground-off particles and facilitates ignition. Rarely fire is made by working the drill on a plane surface, in single, nonconnecting holes.

The difference between these features is that it is found to be more difficult to get fire by a single hole without groove or slot than when the latter features are added. The powder forms a ring around the edge of the hole, is liable to be dispersed, and does not get together in sufficient amount to reach the requisite heat for ignition. Of course this is obviated when a second hole is bored connecting with the first, when the latter becomes a receptacle for the powder.

It is found that these different ways are due to environmental modification, showing itself as remarkably in fire making as in any other Eskimo art. Both the stepped and central-hole hearth are different devices for the same end. The step on the hearth is to keep the pellet of glowing powder from falling off into the snow, so universal in Eskimo land; hence, the simple hearth of primitive times and peoples of warmer climates has received this addition. The same reason caused the Eskimo to bore the holes in the middle of the block.

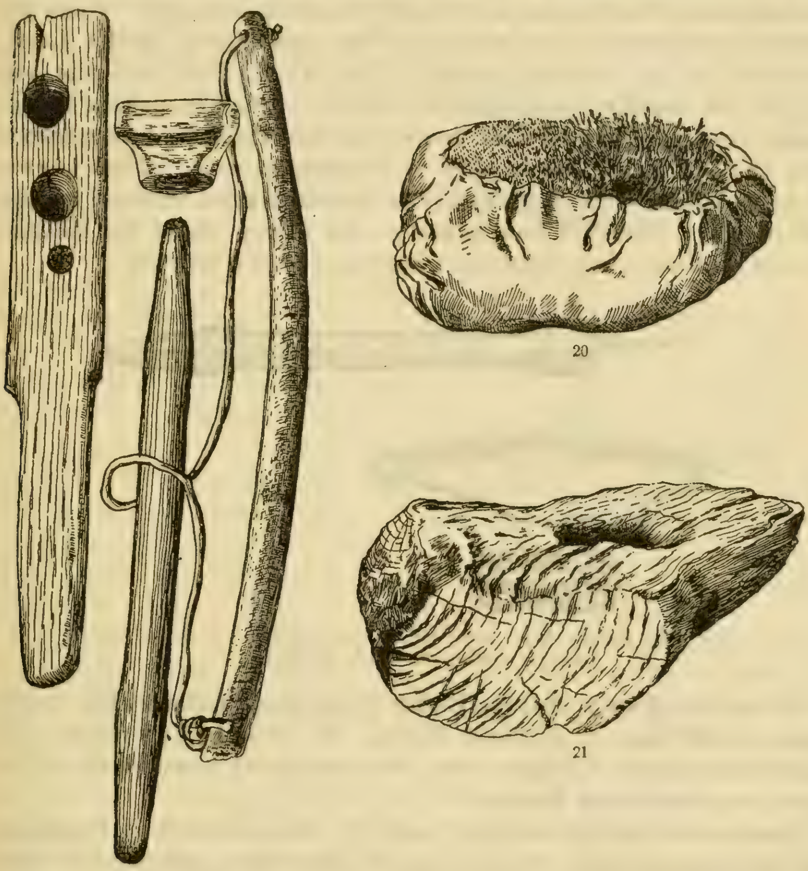
By following the distribution of the center-hole method a clew may perhaps be gotten to the migrations of the Eskimo.

From Labrador to Norton Sound, by the collections in the Museum, the center hole is alone used; south of Norton Sound both methods prevail, with a preponderance of the stepped-hearth species. The step seems to be an addition to the Indian hearth; the center is an independent invention.

The operation of the drill is well told in the oft-quoted description by Sir E. Belcher. The writer can attest to the additional statement that the teeth of civilized man can scarcely stand the shock. He says:

The thong of the drill bow being passed twice around the drill, the upper end is steadied by a mouthpiece of wood, having a piece of the same stone embedded, with a countersunk cavity. This, held firmly between the teeth, directs the tool. Any workman would be astonished at the performance of this tool on ivory; but having once tried it myself, I found the jar or vibration on the jaws, head, and brain quite enough to prevent my repeating it.[31]

The ethnographical study of the Eskimo fire drill begins with Labrador, including Greenland and following the distribution of the



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FIGS. 19–21.—FIRE-MAKING SET AND EXTRA HEARTH. CAT. NO. 10258, U.S.N.M. FROBISHER BAY. COLLECTED BY C. F. HALL. 20, MOSS IN A LEATHERN CASE. CAT. NO. 10191, U.S.N.M. COLLECTED BY C. F. HALL

people among the islands and around the North American coast to Kodiak Island and the Aleutian chain. The following is an interesting account from Labrador, showing what a man would do in the exigency:

He cut a stout stick from a neighboring larch, and taking out the leather thong with which his moccasins were tied, made a short bow and strung it. He then

[31] Trans. Ethnol. Soc., p. 140, London, 1861.

searched for a piece of dry wood, and having found it, cut it into shape, sharpened both ends, and twisted it once around the bowstring; he then took a bit of fungus from his pocket and put it into a little hole which he made in another dry piece of wood with the point of the knife. A third piece of dry wood was fashioned into a handle for his drill.[32]

Eskimo in other localities often use such makeshifts. Cup cavities are often observed in the handles of knives and other bone and ivory tools where they have used them for heads of the fire drill.

Cumberland Gulf is the next locality to the northward. There are several specimens in the collection from this part of Baffin Land, procured by the famous explorer, Capt. C. F. Hall, and the less known, but equally indefatigable Kumlein. The fire-making implements from Cumberland Gulf have a markedly different appearance from those of any other locality in the Eskimo area. They have a crude look, and there is a paucity of ornamentation unusual among this people. The drill bow is one of the things which the Eskimo usually decorates, but these bows have not even a scratch.

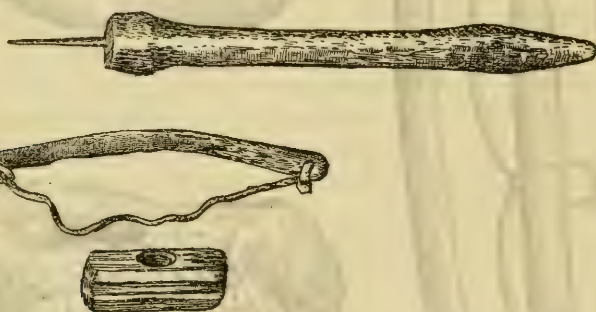

FIG. 22.—BORING SET. CAT. NO. 34114, U.S.N.M. CUMBERLAND GULF. COLLECTED BY L. KUMLEIN

It can be inferred that in Baffin Land more unfavorable conditions prevail than in southern Alaska. It must be this cause, coupled with poor food supply, that have conspired to make them the most wretched of the Eskimo.

The hearth (fig. 19) is of drift oak. It was collected at Frobisher Bay by Captain Hall. It has central holes, and appears to be very unfavorable wood for fire making. A skin bag of moss (fig. 20) is for starting the fire. The block hearth is also from Frobisher Bay. (Fig. 21.) It is an old piece of hemlock, with two central communicating holes. The mouthpiece is a block of ivory. Another mouthpiece is a bit of hardwood soaked in oil; it was used with a bone drill having an iron point. A very small, rude bow goes with this set. (Fig. 22.)

[32] Hind. Labrador, vol. 1, p. 149.

Our knowledge of eastern Greenland has been very much increased by the explorations of Holm and Garde, who reached a village on the east coast never before visited by a white man. Extensive collections were made, both of information and specimens. In reference to fire making, Mr. Holm reports:

They make fire by turning a hard stick, of which the socket end is dipped in train oil, very rapidly around by means of a sealskin thong with handles. This stick is fixed at one end into a head set with bone, and the other end is pressed down into a cavity on the lower piece of wood. (Fig. 23.) Therefore there must be two persons in order to make a fire. One turns the drill with the cord while the other presses it down on the hearth; both support the block with their feet. As soon as the dust begins to burn they fan it with the hand. When it is ignited they take it and put it into dried moss (*sphagnum*), blow it, and soon get a blaze. In this way they make a fire in an incredibly short time.[33]

In the preliminary report, Mr. Holm gives the time at almost less than half a minute. It was made by the Eskimo, Illinguaki, and his wife, who, on being presented with a box of matches, gave up their drill, saying that they had no further use for it.

In the same report Mr. Holm gives an interesting note. He says:

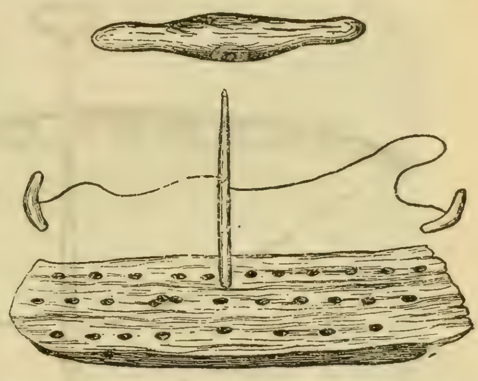

FIG. 23.—FIRE-MAKING SET. ANGMAGSALIK ESKIMO, EASTERN GREENLAND. COPIED FROM G. HOLM'S ETHNOLOGISK AF ANGMAGSALIKERNE, 1887

This fire apparatus is certainly better developed than that which has been described and drawn by Nordenskiöld from the Chukchis.[34] The principle is the same as the Greenlander's drill, which they employ for making holes in wood and bone, and which is furnished with a bow and mouthpiece.[35] (Fig. 24.)

The central holes of this hearth are worthy of note, occurring in the farthest eastern locality of the Eskimo, and in Labrador.

Western Greenland.—The material in the Museum from western Greenland is very scanty. The southern coast has been settled for so long a time that the Eskimo and many of their arts have almost become extinct. No view of fire making in Greenland would be complete without Davis's quaint description of it, made 300 years ago, but it was the upper end of the spindle that was wet in trane. A Greenlander "begaune to kindle a fire in this manner: He tooke a

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[33] Danish Umiak Expedition to Eastern Greenland, 1888, p. 28. Pl. 14 contains the figure.

[34] Voyage of the *Vega*, vol. 2, p. 126.

[35] Danish Umiak Expedition. Preliminary Report, p 208. This seems scarcely what would be inferred from the development of these inventions.

piece of boord wherein was a hole half thorow; into that hole he puts the end of a round sticke like unto a bedstaffe, wetting the end thereof in Trane, and in a fashion of a turner with a piece of lether, by his violent motion doeth very speedily produce fire."[36]

Eskimo graves and village sites yield evidence also that the fire-making tools were not different from those at present used higher north along the coast and on the east coast.

Doctor Bessels, speaking of Itah Eskimo of Foulke Fiord in Smith Sound, says: "The catkins of the Arctic willow are used as tinder to catch the sparks produced by grinding two pieces of stone. Also the widely diffused 'fire-drill' is found here; the spindle is held between a piece of bone and a fragment of semi-decayed wood, and is set in

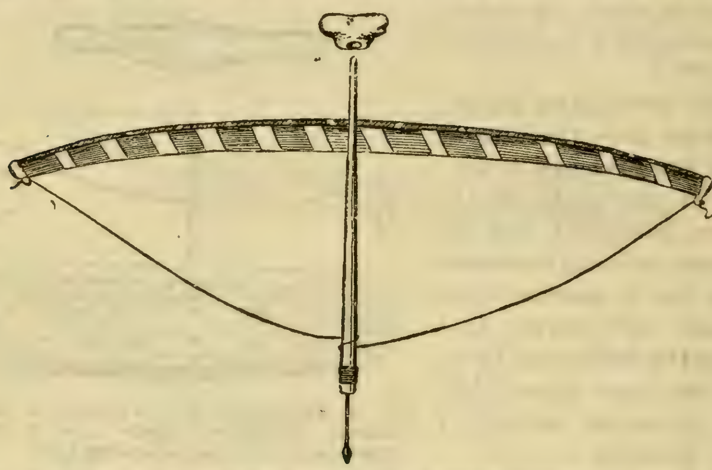

FIG. 24.—BORING SET. (ANGMAGSALIK ESKIMO, EASTERN GREENLAND. G. HOLM'S ETHNOLOGICK OF ANGMAGSALIKERNE)

motion by the well-known bow, and is turned until the wood begins to ignite."[37]

The "fire bag" is an accompaniment to all sorts of fire-making apparatus. The fire bag shown (fig. 25) was collected by Captain Hall, at Holsteinberg, western Greenland in 1860. It is made of sealskin, and is a good specimen of the excellent needlework of these Eskimo. It was used to carry, more especially, the fire drill and tinder which require to be kept very dry.

There is a wide gap in the collections of the Museum between the locality of the specimen just mentioned and the fire hearth from the Mackenzie River. (Fig. 26.) This specimen is from Fort Simpson presumably, where B. R. Ross collected. It is said to be difficult to discriminate the Eskimo from the Indian on the lower Mackenzie. This hearth may be Indian, as it has that appearance; besides, no

[36] Hakluyt Society, vol. 3, p. 104.
[37] Die amerikanische Nordpol-Expedition, p. 358, Leipzig.

Eskimo hearth yet observed has side holes and slots like this without the step. The Indians of this region are of the great Athapascan stock of the North. The close resemblance of this stick to the one from the Washoans of Nevada has been commented upon. (See fig. 6, p. 14.)

There is a very fine old central-hole hearth from the Mackenzie River, collected also by Mr. Ross. It is a rough billet of branch wood, cut apparently with an ax, or hatchet. (Fig. 27.) It is semi-decayed and worm eaten. It has 10 central holes where fire has

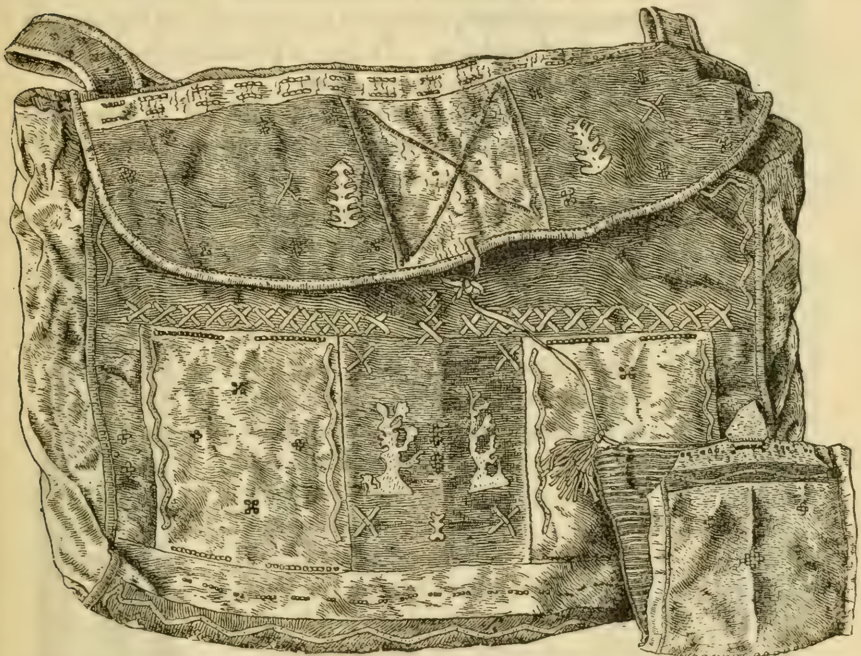

FIG. 25.—FIRE BAG. CAT. NO. 10128, U.S.N.M. ESKIMO OF HOLSTEINBERG, WEST GREENLAND. COLLECTED BY CAPT. C. F. HALL

been made; they are quite deep, forming a gutter in the middle of the hearth. There is, as can be seen, no need of a groove, as the dust falls over into the next hole, collects in a mass, and ignites.

The Anderson River set is a very complete and interesting outfit. It was collected many years ago by C. P. Gaudet. The parts are small for convenience of carrying. It is the custom of those who live in snow-covered regions to wrap the drill and hearth together very carefully to keep them dry, as these are the essential parts of the apparatus. It does not matter about the mouth-piece or bow. In this example there is a groove cut along the bottom of the hearth in order to facilitate tying the drill and hearth securely together. The

hearth is a square block of soft wood with three central holes. (Fig. 28.)

The other parts of this set are also worthy of consideration. The mouthpiece is set with a square piece of black stone. The part held in the mouth is very much chewed. One of the wings has a hole for tying, as has the hearth.

This is an unusual Eskimo precaution to prevent small objects from being lost in the snow. The drill is short, being only 7 inches long. The bow is the fibula of a deer, pierced at each end for the frayed thong of sealskin. It has a primitive look, but it admirably serves its purpose.

The Point Barrow set was collected by the most successful expedition under charge of Lieut. P. H. Ray, United States Army. The knucklebone of a deer serves as a mouthpiece, the cup cavity and its general shape fitting it for the purpose admirably.

The drill is regularly made of light pine wood; it is slightly smaller in the middle. The hearth is a rudely rounded piece of pine. A fragment has been split off, and on this surface a groove has been cut and three fire holes bored along it. The thong is without handles; it is used to tie the parts together when they are not in use. A bunch of willow twigs, the down of which is used as tinder, is also shown. (Fig. 29.)

This set is especially interesting, because it shows the degeneration of an art. The fire drill is so rarely used at Point Barrow, John Murdoch says, that it was not possible to get a full set devoted to that purpose. Those here shown are a makeshift. The method only survives by the conservatism of a few old men of the tribe, who still cling to old usages. One of these made the drill for Lieutenant Ray, telling him that it was the kind used in

FIG. 26.—LOWER PART OF FIRE-MAKING SET (ON ONE END IS GUM FOR CEMENT). CAT. NO. 1978, U.S.N.M. MACKENZIE RIVER, BRITISH COLUMBIA. COLLECTED BY B. R. ROSS

FIG. 27.—LOWER PART OF FIRE-MAKING SET. CAT. NO. 1963, U.S.N.M. ESKIMO OF MACKENZIE RIVER, BRITISH COLUMBIA. COLLECTED BY B. R. ROSS

old times. It seems primitive enough; the knucklebone might well have been the first mouthpiece. The Eskimo farther east sometimes use a fish vertebra for the same purpose; one from the Anderson River has this. The cord without handles is undoubtedly the earliest form also.

The small wooden and bone mouthpieces of the Eskimo east of Point Barrow to Cumberland Gulf seems to be copies of the deer knucklebone. Another primitive adaptation is found in an Anderson River bow, which is made of the fibula of a deer. (See fig. 28.)

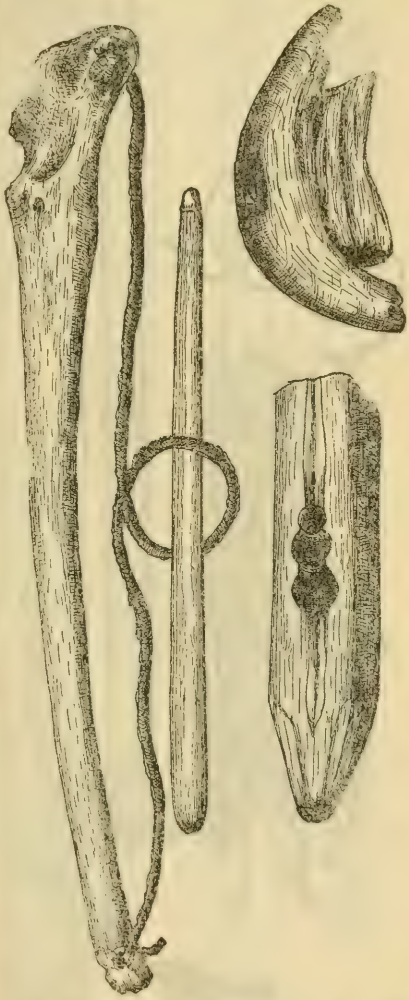

FIG. 28.—FIRE-MAKING SET. CAT. NO. 1327, U.S.N.M. ESKIMO OF ANDERSON RIVER, BRITISH COLUMBIA. COLLECTED BY C. P. GAUDET

The fire-making drill collected from the Chukchis by the *Vega* expedition in the Cape Wankerem region, in northeastern Siberia, about the same latitude as Point Barrow, is figured in Nordenskiöld's report.[38] It is worked by a bow, and the drill turns in a mouthpiece of a deer astragalus like the Point Barrow specimen. The block has central holes, with short grooves running into each one.

Nordenskiöld's description of the manner of making fires is very detailed. He records that the "women appear to be more accustomed than the men to the use of this implement."

He gives also a most interesting observation on the use of a weighted pump drill among the Chukchis. The Chukchis also use flint and steel.[39]

The drilling set from Point Barrow shows the appearance of the parts of the fire drill if we substitute the round stick for the flint drill. Some of the old drill stocks are pointed, with finely chipped flint heads. The length of these points varies from 2 to 4 inches;

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[38] Voyage of the *Vega*, London, 1881, vol. 2, pp. 121, 122.

[39] Idem, vol. 2, pp. 120, 121.

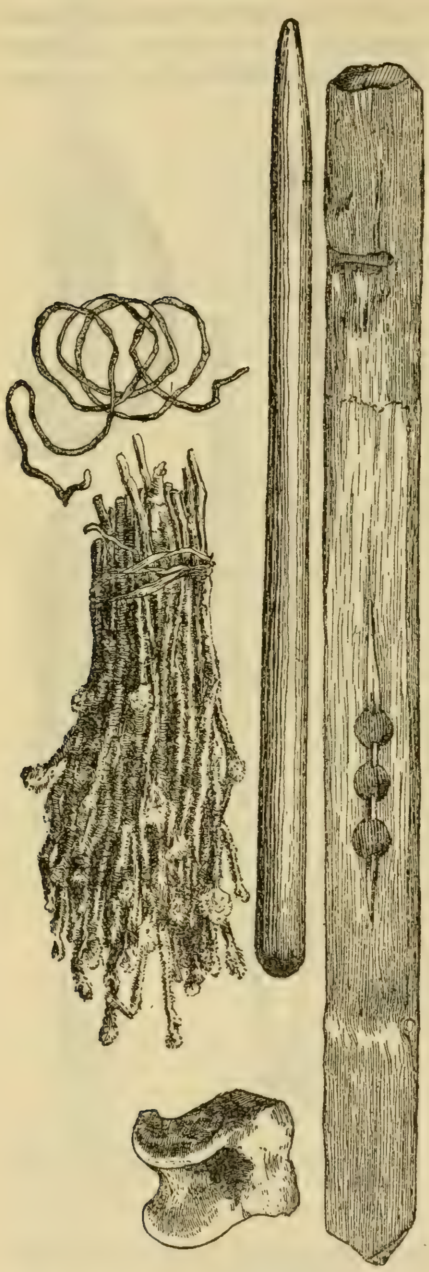

FIG. 29.—FIRE-MAKING SET (WITH MOUTHPIECE OF DEER'S KNUCKLEBONE, THONG, AND TINDER OF WILLOW CATKIN). CAT. NO. 89822, U.S.N.M. ESKIMO POINT BARROW, ALASKA. COLLECTED BY P. H. RAY

the transverse section of one would be a parabola. They are in general more finely wrought than any of the prehistoric drills found in various localities all over the world. Prehistoric man was an adept in the art of drilling stone, bone, and shell; the stone tubes, some of them 18 inches long, bored very truly, are triumphs of the American Indians. Without doubt the prehistoric drill points were mounted like the Eskimo specimen, and were, perhaps, twirled between the hands, the almost universal method of using the fire drill. Japanese carpenters drill holes in this way.

The winged mouthpiece is also a good example of workmanship. It is set with a mottled, homogeneous stone that is tolerably soft, which gives a minimum friction. This stone is much affected by the tribes over quite an extent of coast for labrets, etc. It is probably an article of trade as are flints. The bow is of walrus tusk, accurately made, but poorly engraved in comparison with the lifelike art work of the southern Eskimo.

Another drilling set is from Sledge Island. The Museum has no fire-making specimen from this locality. The drill stock is set with a point of jadeite lashed in with sinew cord. The bow is of walrus ivory; it is rounded on the belly and flat on the back. All Eskimo bows of ivory have a like curve, no doubt determined by the shape

of the walrus tusk. In another, the most common form of the bow, its section is nearly an isoceles triangle, one angle coming in the center of the belly of the bow. The head is intended to be held in one or both hands; it agrees in form with the rude St. Lawrence Island heads.

Dr. E. W. Nelson collected at Unalakleet, in Norton Sound, a fire drill, and the native names of the parts. The name of the set is "ŏŏ-jŏŏ-gŭtat"; the mouthpiece, "nă-ghŏŏ-tuk"; the drill, "ŏŏ-jŏŏ-ga-tuk"; the hearth of tinder wood, "athl-uk"; the bow, "arshu-lŏw-shuk-pish-ik-sin-uk."

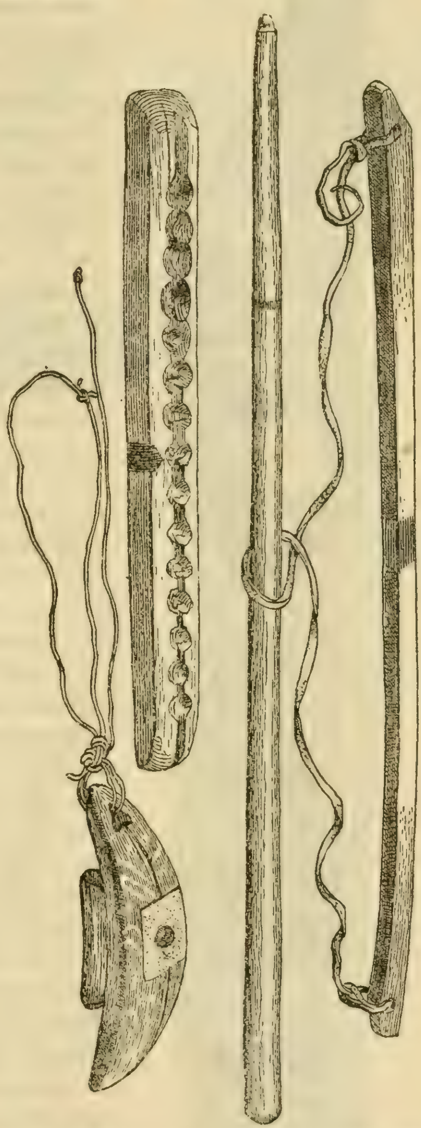

FIG. 30.—FIRE-MAKING SET (HEARTH SHOWING MEDIAN GROOVE). CAT. NO. 33166, U.S.N.M. ESKIMO OF NORTON SOUND, ALASKA. COLLECTED BY E. W. NELSON

This is a complete set (fig. 30) in first-rate order. The hearth has central holes along a deep median groove. Its bottom is flat, and it is rounded off on the sides and ends. All the parts are of pine wood, decorated in places with red paint. The drill is quite long, much longer than in any Eskimo set observed. It resembles more the Indian drill for rubbing between the hands. The bow is of wood, which also is quite the exception in other Eskimo regions, where it is of ivory. There are many bows of antler from Norton Sound in the Museum, some of them skillfully and truthfully engraved. The mouthpiece is plain; not very well made. It is set with a square block of marble. It has the usual hole in one of the wings for the passage of a thong.

Fig. 31.—Lower piece of fire-making set (hearth). Cat. No. 39601, U.S.N.M. Eskimo of Cape Vancouver, Alaska. Collected by E. W. Nelson

Cape Vancouver is represented by a fine old hearth. This object has evidently been prized by its owner; it has had two rows of fire holes (fig. 31), one row bored on the step in front of the first holes made; some of the holes are bored clear through. The reason why this was valued is because the wood is so tindery that it is easy to make fire upon it.

Chalitmute, in the Kuskokwim region, on the northern side of the bay of that name, opposite Nunivak Island, is the next locality southward to be considered. The parts of this set are exceptionally well finished. The hearth (fig. 32) is stepped. It has four holes prepared for use; on one, fire has been made. The drill is unusually thick. The mouthpiece has no teeth grip, and there is no evidence that it was ever held in the mouth. It is intended to be held in the hand. This mouthpiece is set with an oval socket stone of black obsidian, ground down into facets and polished. The cord handles are fine, large teeth of the sea lion. The centers of the circles so characteristic of Eskimo art are inlaid with wood. The holes for the drill cord are narrow; they must have been dug through with a sharp, narrow instrument. As before remarked, this is the region where the hand rest is more used than the mouthpiece, and the bow is not used at all.

The fire-making set from the Togiak River was collected in 1886 by Sergt. I. Applegate, of the United States Signal Corps. Kassianamute, from which village it comes, is in the Bristol Bay region, but this set has a different appearance from the former outfits. (Fig. 33.) The hearth is a block of wood worked out at one end into a handle. It is remarkable in having central holes not connecting, and with no connecting grooves. In this it closely resembles the block from east Greenland. (Fig 23.) This hearth is of soft, tindery wood, and doubtless when the holes became too deep to allow the powder to mass

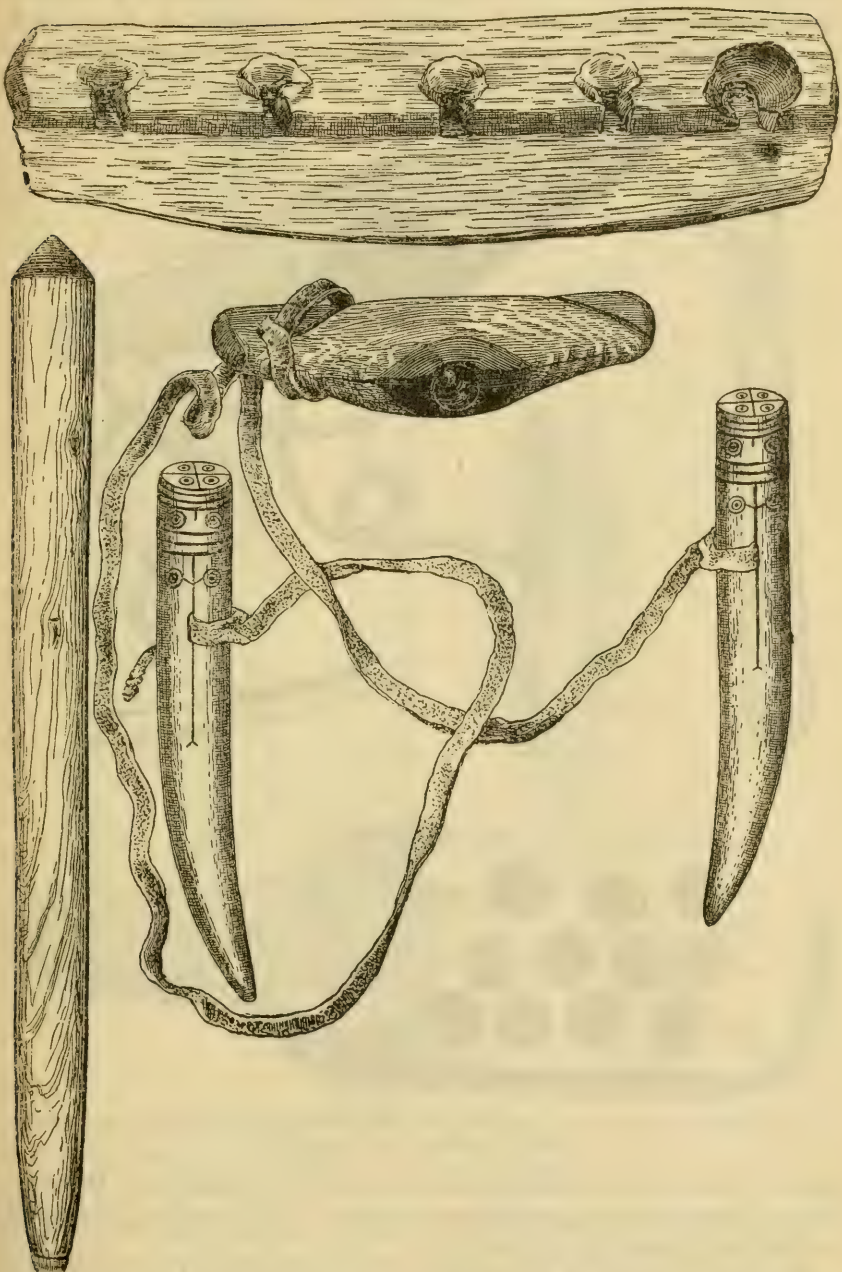

FIG. 32.—FIRE-MAKING SET. CAT. NOS. 36325 AND 37961. ESKIMO OF CHALITMUTE, KUSKOKWIM REGION, ALASKA. COLLECTED BY E. W. NELSON

around the edge the upper part of hearth was scraped down. The mouthpiece is large and is in the form of a seal. It has only a shallow, crescentic teeth grip; from the size of the mouthpiece, its shape, and the absence of a block to fasten between the teeth it must have been

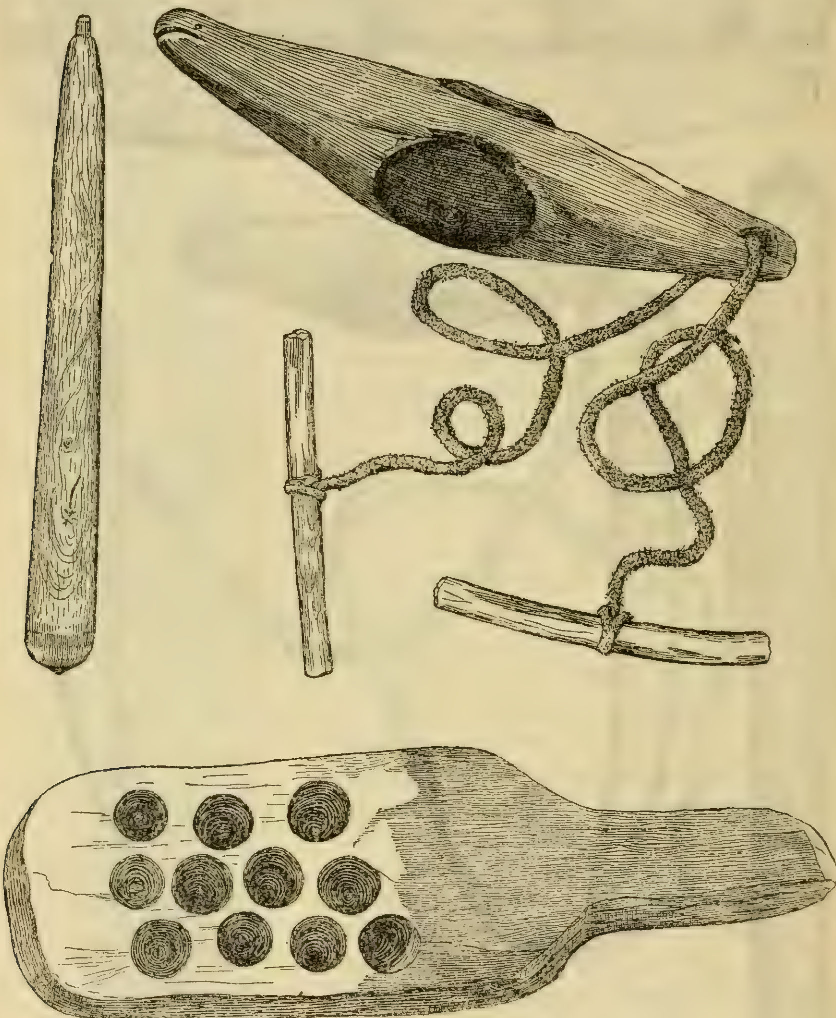

FIG. 33.—FIRE-MAKING SET. CAT. NO. 12750, U.S.N.M. ESKIMO OF KASSIANAMUTE, TOGIAK REGION, ALASKA. COLLECTED BY I. APPLEGATE

nearly always held in the hand of one of the operators. It is set with a round pebble, mottled with green. The cord is a thong of rawhide with handles of wood.

The next locality is Koggiung, on the southern shore of Bristol Bay, near its head. Two sets are shown from this locality. From the hearths it will be seen that both fire slots on the side and

center holes are used here. These sets are called "nŭ-tshŭn." (Fig. 34.) The apparatus shown in Figure 34 has the stepped hearth.

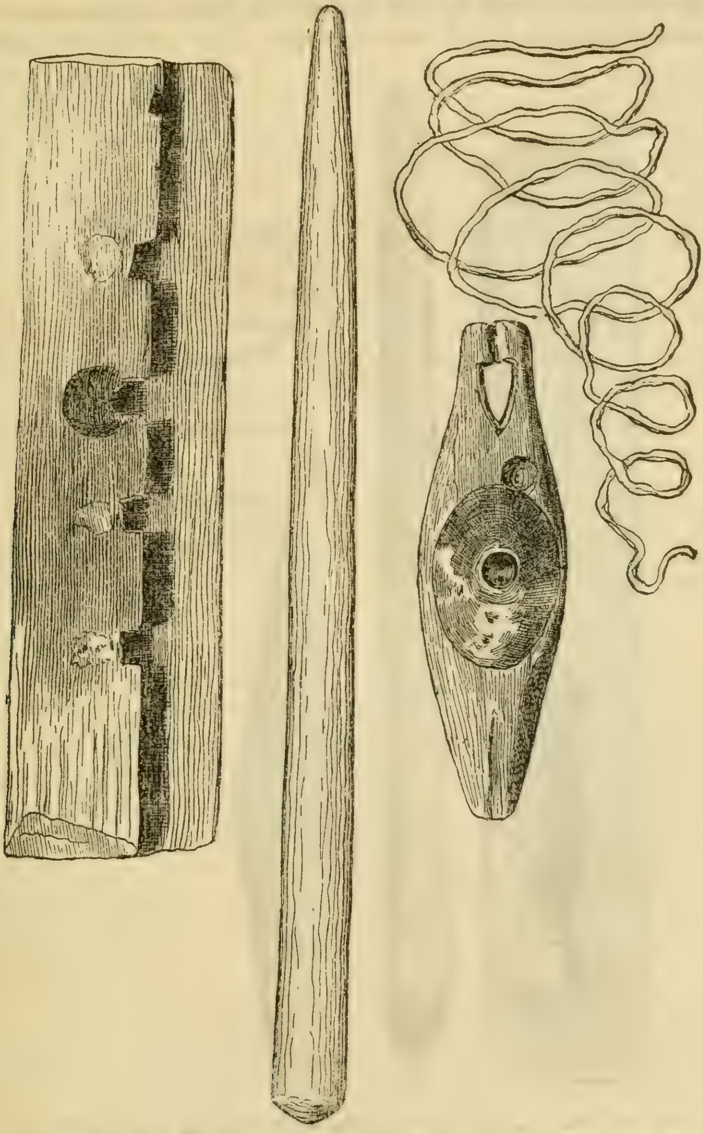

FIG. 34.—FIRE-MAKING SET (HEARTH WITH STEP AND FIVE SLOTS). CAT. NO. 127819A, U.S.N.M. KOGGIUNG, BRISTOL BAY, ALASKA. COLLECTED BY W. J. FISHER

Both drill and hearth apparently have been made for sale. The mouth-piece is a good one, set with a large socket piece of a black stone with green mottlings. This stone is tolerably soft. It is much used by the Bristol Bay Eskimo for making labrets, etc. The teeth grip is

very shallow. The hearth (fig. 35) is of a very peculiar shape; only one other has been noticed like it. The wood is of the best kind, and fire has been made on it a number of times. In several places the holes have been bored clear through. The mouthpiece bears no

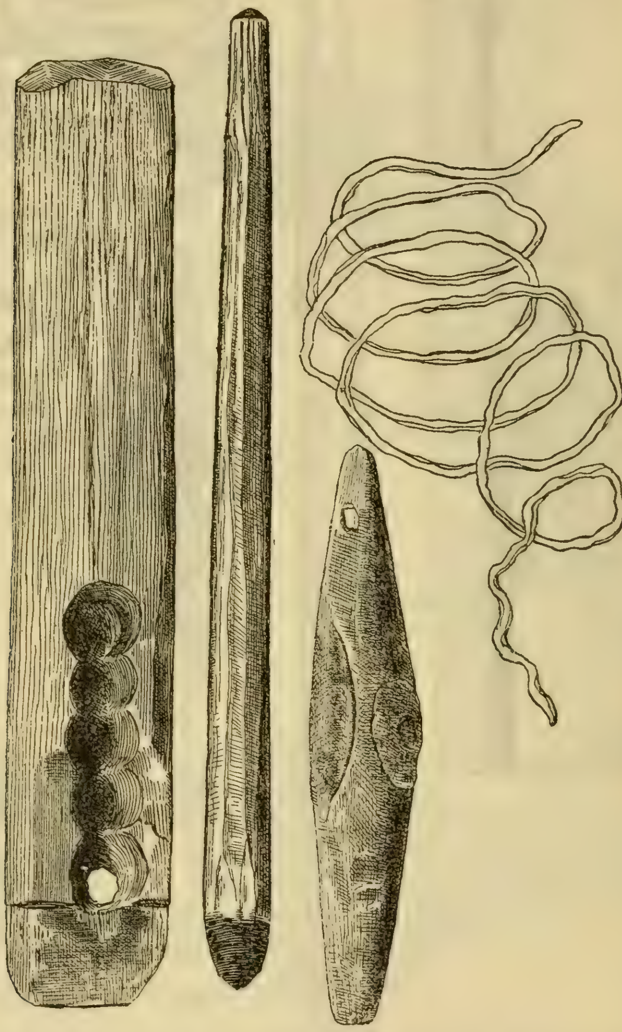

FIG. 35.—FIRE-MAKING SET (HEARTH WITH CENTRAL HOLES AND END STEP). CAT. NO. 127819B, U.S.N.M. KOGGIUNG, BRISTOL BAY, ALASKA. COLLECTED BY W. J. FISHER

evidence that it has been held between the teeth. It is highly probable that fire was made on these outfits more often by two persons, one holding the mouthpiece, or rest, and fanning the flame, the other pulling the cord. This must be the method in Bristol Bay. Neither

the true mouthpiece nor any bow has been procured by the Museum from this interesting region, from whence there are copious collections of ethnological objects. The cords without handles are worthy of notice.

Another set from Bristol Bay is said by its collector, Charles McKay, to be used by both Eskimo and Indians. It is a very valuable outfit because of its completeness. (Fig. 36.) The hearth is a rounded piece of wood with four large holes opening by slots onto the step. The drill is a thick, tolerably hard piece of close-grained wood like the hearth. The mouthpiece has no regular block for the teeth grip, but has a crescentic gash on each side instead. It is set with a socket of a rock resembling marble. Nearly all the mouthpieces south of Norton Sound are in the shape of seals or other long animals. Cord handles are used attached to a thick thong of buckskin. Fungus is used for tinder and a blaze is started with cones of the larch. These are kept in the box, the lid of which is tied on with a thong.

Kodiak, the lowest limit of the western Eskimo, is as far south as the four-part fire drill extends by specimens in the Museum. (Fig. 37.) The hearth is of cedar wood with three central holes with a connecting groove. It is neatly finished. The drill is also of cedar and bears the marks of the use of a thong; the top has also been used in the socket of a rest. The drill approaches in length those used for twirling between the hands by the Indians.

While the Aleutians use flint and steel, or a stone containing quartz and pyrites, struck against another stone, they still make use of the four-part drill at certain times. Hunting parties, says L. M. Turner, carry the drill to use when their matches run out. It takes two men to work it, one holding the hand rest and the other pulling the thong. The spindle is made of harder wood, so as to wear the light dust which ignites, from the hearth. A moment only is necessary to get fire; this is fed with tinder made of willow catkins and powdered charcoal. Sometimes, in order to get fire, they hold tinder at the mouth of a gun and ignite it by firing off a light charge of loose powder.

Possessed of four methods of getting fire, the Aleutian is superior to more fortunately situated people who depend wholly on matches.

Pump drill.—It appears probable that the pump drill is of Asiatic origin as there are frequent occurrences of this implement in Asia. There is also a pretty uniform distribution of the pump drill across Siberia. Some western Eskimo and Indians use the pump drill for fire making, and it is possible that it was disseminated in Nearctic Canada and the United States at an early period and surviving now in only a few places, as among the Iroquois.

The Iroquois are unique in the United States in making fire with the pump drill. It is well known that several American tribes used the pump drill for drilling beads and for other light, fine work

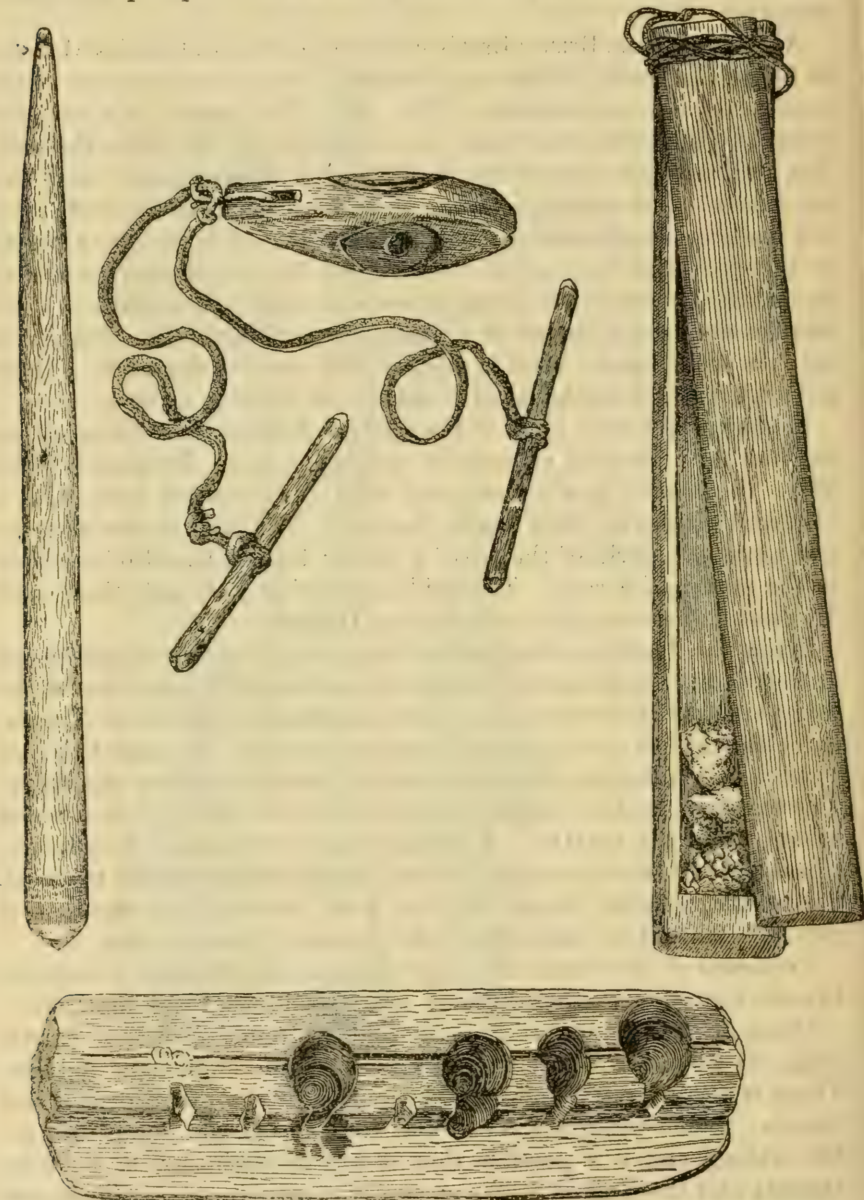

FIG. 36.—FIRE-MAKING SET. CAT. NO. 55938, U.S.N.M. ESKIMO OF BRISTOL BAY, ALASKA. COLLECTED BY CHARLES McKAY

requiring little friction and pressure. To render the pump drill effective for fire making it was necessary to increase the size and add a heaver balance wheel. Even then the pump drill is a clumsy fire

producer and hardly a practical tool for the purpose.

How long the Iroquois have had the fire drill is conjectural, but observers as early as 1724 do not mention its use, speaking only of the simple two-stick drill.

II. FIRE MAKING BY SAWING

Prof. Alfred Russell Wallace in his work entitled "The Malay Archipelago," (p. 332) has noted the method by sawing two pieces of bamboo; a sharp-edge piece like a knife is rubbed across a convex piece in which a notch is cut, nearly severing the bamboo (fig. 38); after sawing across for awhile the bamboo is pierced, and the heated particles fall below and ignite. The Ternate Malays and the Tungaras of British North Borneo [40] have improved upon this by striking a piece of china with tinder held with it against the outside of a piece of bamboo, the siliceous coating of the latter yielding a spark like flint. Both of the methods mentioned are in use at different points in the area affected by Malay influence.

The Chittagong hill tribes, on the eastern frontier of British India, use sand on the sawing knife to increase the friction.[41]

The Karens of Burma, Dr. R. M. Luther informs the writer, hollow out a branch of the *Dipterocarpus* tree like the lower piece of bamboo spoken of, cut a transverse notch, and saw across in it with a rubber of ironwood. The wood fibers ground off form the tinder; the coal is wrapped up in a dry leaf and swung around the head till it blazes. It takes only two or three minutes to get a blaze this way.

Bearing upon the origin of this method of sawing in these localities, nature is

FIG. 37.—LOWER PIECE AND SPINDLE OF FIRE-MAKING SET. CAT. NO. 72514, U. S. N. M. ESKIMO OF KODIAK ISLAND, ALASKA. COLLECTED BY W. J. FISHER

[40] D. D. Daly. Proc. Roy. Geog. Soc., p. 10, 1888.

[41] Capt. T. H. Lewis. Hill tribes of Chittagong, p. 83. Calcutta, 1869.

alleged to suggest the way and to repeat the process that would give to fireless man the hint. Dr. W. T. Hornaday relates that many fires are started in the jungle by bamboo rubbing together in a high windstorm. The creaking is indiscribable; the noise of the rasping and grinding of the horny stems is almost unendurable.

FIG. 38.—MALAY FIRE STICKS. CAT. NO. 129775, U.S.N.M. MODELS IN BAMBOO MADE BY DOCTOR HOUGH AFTER A. R. WALLACE'S DESCRIPTION. THE MALAY ARCHIPELAGO, P. 332.

In many tribes it is found that often there is more than one method of fire-making practiced. For instance, in Borneo, as we have seen, the Tungaras use the sawing method, the Saribus Dyaks the "besiapi," or fire syringe, a most interesting fact,[42] other Dyaks the rotary drill,[43] while the Rev. Dr. Taylor says that the Dyaks are acquainted with the use of the bow and string and the upright stick and cord (pump drill). In connection with all these methods probably flint and steel were used.

So in Australia, while the rotary drill is the usual way, some tribes have acquired the art of producing fire with knife or rubber—that is, the sawing method presumably under foreign influence.[44]

The specimens of fire saws in the Museum come from the Philippines, collected 25 years ago. They indicate that a node of bamboo from 13 to 15 inches long was sectioned longitudinally for the lower piece and the saw made by splitting off a narrower piece and sharpening one or both edges. In the middle of the hollow of the lower piece fibers are torn up, forming a groove which reduces the thickness of the wall of the bamboo, allowing the saw to cut through to the tinder affixed in the groove and held in place by loose fibers. The saw is worked across the bow of the bamboo hearth at right angles over the spot where the tinder had been previously located. Sometimes this is reversed by holding the saw firmly edge up and rubbing the hearth on it. The use of the fire saw was quite general in the Philippines among all the tribes, while the hand drill or or plow were not used so far is known in the entire archipelago. The specimens shown are from Mindanao and Luzon. (Pl. 8, figs., 1, 1*a*, 2, 2*a*, Cat. No. 216,716; Col. F. F. Hilder; 13.5 inches long and 15 inches long (34.5 cm. and 38 cm.).

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[42] The American Anthropologist, vol. 1, No. 3, p. 294. Washington, 1888.
[43] J. G. Wood. The Natural History of Man, vol. 2, p. 502.
[44] R. Brough Smyth. The Aborigines of Victoria, vol. 1, p. 393. London, 1878.

III. FIRE MAKING BY PLOWING

One of the most marked of fire-making methods in its distribution is that pursued by the Pacific Islanders, confined almost entirely to the Polynesian cultural area. It has spread to other islands, however, being met with among the Negritos of New Britain:

> They rub a sharpened piece of hard stick against the inside of a piece of dried split bamboo. This has a natural dust that soon ignites. They use softwood when no bamboo can be procured, but it takes longer to ignite. The flame is fed with grass.[45]

There is a close connection between the Malay sawing method and this, as there is a decided Malay preponderance in the make-up of the population of the islands.

The fire sticks shown (fig. 39) were procured by Harold M. Sewall, at Samoa, and deposited in the Museum by him.

The wood is a light corky variety, characteristic of the *Parite tiliaceum*, which is used for this purpose at Tahiti and many other islands. The rubber may be of some hardwood, although fire may be made by means of a rubber of the same kind of wood as that of the hearth, though no doubt it requires a longer time to make fire if this is done. In the Sandwich Islands, Franklin Hale Austin, secretary of the King at that period, says that the rubber is of "koh" or "ohia"—that is, hardwood—and the hearth of "koh," or softwood, and the friction is always in softwoods; this is true, I believe, everywhere this method is practiced, is in spite of the fact that a soft rubber on hardwood will asnwer as well.

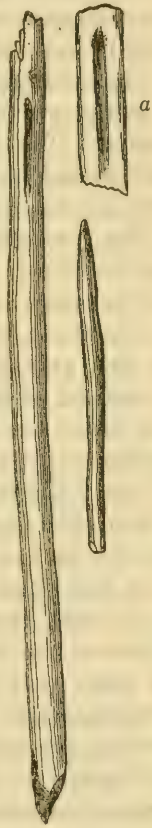

FIG. 39.—FIRE-MAKING STICKS (*a* SHOWING GROOVE). CAT. NO. 130675, U.S.N.M. SOMOA. DEPOSITED BY HAROLD M. SEWALL

Lieut. William I. Moore, United States Navy, gave the writer a complete description of the manipulation of the Samoan fire-getting apparatus.

The blunt-pointed stick is taken between the clasped hands, somewhat as one takes a pen, and projected forward from the body along the groove at the greatest frictional angle consistent with the forward motion which has been found to be from 40° to 45°. Kneeling on the stick the man forces the rubber forward, slowly at first, with a range of perhaps 6 inches, till the wood begins to be ground off and made to go into a little heap at the end of the groove; then he gradually accelerates the speed and moves with a shorter range until, when he pushes the stick with great velocity, the

[45] W. Powell. Wanderings in a Wild Country, p. 206.

brown dust ignites. This is allowed to glow and if it is required to be transferred to dry leaves or chips of wood it is done by means of a tinder made of frayed or worn tapa cloth.

The groove (fig. 39*a*) is the most characteristic feature of this apparatus, there being apparently no definite form of implements for this purpose. Fire is made on any billet of dry wood that is available. It is not necessary to cut a slot, or even a groove; the hardwood rubber will form one, so that there is no more need of apparatus than among the Navahos, where two bits of yucca stalk collected near by form the fire tools.

That making fire by this way is difficult to those inexperienced in it is not strange. Mr. Darwin found it quite so, but at last succeeded. The Samoan gets fire in 40 seconds, and so great is the friction and the wood so well adapted that Mr. Austin, before quoted, says it sometimes actually bursts into flame.

The Australians in some parts use a method very much like the one described. They rub a knife of wood along [46] a groove made in another stick previously filled with tinder.[47]

Fire thong.—While there is no apparent connection between the fire drill and the fire saw, plow, and thong, there is an approximation in method of operation among the three latter—that is, the fire saw and thong are in close relationship, the plow is related but stands farther away, while the drill is unrelated.

Henry Balfour has most successfully monographed the fire thong.[48] The method has been found in use in southeastern Asia and the Asiatic islands; in New Guinea; West Africa, and western Europe.

At first sight it would seem necessary to limit the fire thong method to the area of the distribution of the rattan, whose strong texture admits of the hard usage required in making fire. This is generally the case, as it is difficult in other parts of the world to supply the thong material. Some thongs of bark, however, or strips of flexible bamboo, are used in areas where the rattan does not occur.

Matthew W. Stirling, on his expedition to Central New Guinea in conjunction with the Dutch Government, found the fire thong in use among the Pygmies and the fringing Pygmy-Papuan tribes. Curiously enough he found the method employed in sawing down trees. This is quite suggestive of a way by which the fire thong may have been discovered.

The Battaks of the island of Palawan in the Philippines use the thong fire kindler. The thong of rattan is wound into a wristlet and worn till needed. The stick is cleft and held open by a bit of stone. M. W. Stirling brought from the hitherto unvisited Pygmies of New

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[46] This is perhaps across the groove.

[47] R. Brough Smyth. The Aborigines of Victoria, vol. 1, p. 394. London, 1878.

[48] Frictional fire making with a flexible sawing thong. Journ. Roy. Anthrop. Inst., vol. 44, January–June, 1914, pp. 32–64.

Guinea specimens of the thong apparatus identical with the Palawan set described and showing an interesting connection-survival. (Pl. 9, fig. 2, Cat. No. 326012; Mrs. E. Y. Miller; 11.5 in. (29.5 cm.).)

IV. PERCUSSION

1. *Flint and pyrites.*—The art of fire making by striking two stony substances together was begun in the far past, having originated in experiences connected with the working of stone. Since by striking flint against flint no live spark can be gotten to start a fire, it is necessary to infer that by striking two pieces of pyrites together or substituting for one piece a flint, a rather hot spark would be observed to follow the impact. The pyrites strike-a-light was found in use in a number of localities, which seems to indicate a survival of former usage, while in other localities pyrites was used with flint, this arrangement being more workmanlike, obviating the breaking of the fragile pyrites. This ancestor of the flint and steel was in use in the European neolithic age and remained current far into the iron age, being used on guns after the invention of gunpowder.

Presumably the neolithic equipment was a flint scraper, a lump of iron pyrites, tinder, and a bag to contain them. Many of the scrapers of the sort believed to have been those used in fire making are found in European neolithic deposits, but pyrites rarely, as it tends to decay rapidly. (Fig. 40*a*.)

The working of the flint and pyrites in fire making was different from that pursued with the flint and steel. The steel is struck on the edge of the flint with a sharp scraping blow, while the neolithic scraper was chopped on the surface of the pyrites somewhat as a scraper is ordinarily used, shown in Figure 40. The pyrites lump, therefore, being scraped around the sides assumed a cylindrical form. (See fig. 42.)

Dr. Thomas Wilson calls my attention to a discovery of a pyrites nodule by M. Gaillard, in a flint workshop on the island of Guiberon in Brittany. The piece bore traces of use. Doctor Wilson thinks that the curved flakes of flint like the one figured, found so numerously, were used with pyrites as strike-a-lights. The comparative rarity of pyrites is, perhaps, because it is easily decomposed and disintegrates in unfavorable situations in a short time, so that the absence of pyrites does not militate against the theory that it was used. A subcylindrical nodule of pyrites 2½ inches long and bruised at one end was found in the cave of Les Eyzies, in the Valley of Vézère, Perigord, mentioned in Reliquae Aquitanicae (p. 248). This is supposed to have been a strike-a-light.

Prof. W. B. Dawkins thinks that:

In all probability the cave man obtained fire by the friction of one piece of hard wood upon another, as is now the custom among many savage tribes. Sometimes, however, as in the Trou de Chaleux, quoted by M. Dupont (Le Temps

Prehistorique en Belgique, second edition, p. 153), he may have obtained a light by the friction of a bit of flint against a piece of iron pyrites, as is usual with the Eskimos of the present day.[49]

Professor Dawkins also says that fire was obtained in the bronze age by striking a flint flake against a piece of pyrites, sometimes found together in the tumuli. He figures a strike-a-light from Seven Barrows,

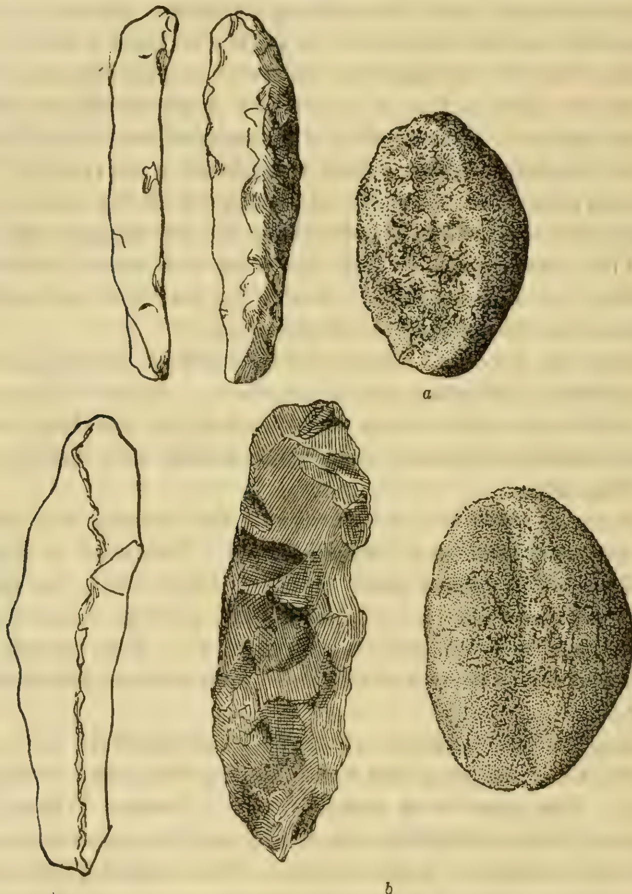

FIG. 40.—*a* STRIKE-A-LIGHT. SEVEN BARROWS, BERKS COUNTY, ENGLAND. FROM DAWKINS EARLY MAN IN BRITAIN, P. 358. (SEE DR. JOHN EVANS ANCIENT STONE IMPLEMENT, PP. 284, 288, FOR A SIMILAR FIGURE); *b* STRIKE-A-LIGHT. CAT. NO. 1861, U.S.N.M. INDIANS OF FORT SIMPSON, MACKENZIE RIVER DISTRICT, BRITISH COLUMBIA. COLLECTED BY B. R. ROSS

Lambourne, Berks, England, an outline of which is reproduced here for comparison with the one from Fort Simpson, British Columbia. (Fig. 40*a* and *b*.) Pyrites has been found in a kitchen midden at Ventnor, in connection with Roman pottery[50] Chambers's Encyclo-

[49] Early Man in Britain, p. 210. London.
[50] Idem, p. 258.

paedia, article, "Pyrites,"[51] is authority for the statement that pyrites was used in kindling powder in the pans of muskets before the gun flint was introduced.

It is thus seen that this art has a high antiquity and that on its ancient areas its use comes down nearly to the present day, the flint and steel being its modern or allied form.

In North America this art is distributed among the more northerly ranging Indian tribes and the Eskimo of some parts. Its use was and is yet quite prevalent among the Indians of the Athapascan (formerly Tinné) stock of the north. By specimens in the Museum and notes of explorers it is found to range from north of Dixon's Sound to Labrador, the following localities being represented: Stikine River, Sitka, Aleutian Islands, Kotzebue Sound, Point Barrow, the Mackenzie River district, at Fort Simpson, and probably Hershel Island, Pelly Bay, Melville Peninsula, Smith Sound, and Labrador. The Canadian and Algonquins strike two pieces of pyrites (*pierres de mine*) together over an eagle's thigh, dried with its down, and serving instead of tinder.[52] From other sources we know that the extinct Beothucs of Newfoundland did the same.[53]

As far as can be ascertained, the Eskimo and Indians both use the method, so that it is not characteristic of either, as the four-part drill is of the Eskimo, as contrasted with the simple rotation sticks of the Indians. A description of a flint and pyrites outfit, as at present used, will give a general idea of the status of the invention. In different localities the manipulation differs somewhat, as will be noted farther on.

The strike-a-light (No. 128405) was collected by Capt. E. P. Herendeen from natives who told him that it came from Cape Bathurst, hence he assigned the specimen to this locality on the evidence. John Murdoch has, with a great deal of probability, questioned this and thinks that it came from Herschel Island with the rest of Mr. Herendeen's collections and did not come from as far east as Cape Bathurst. While there is no improbability that this method is practiced at Cape Bathurst, yet the specimen has the appearance of the Mackenzie River strike-a-lights, hence it is deemed advisable to locate in the Mackenzie River district at Herschel Island.

The essential parts of the apparatus are a piece of pyrites, a piece of flint, and tinder. In the more northern parts of the Eskimo area tinder is made from the down from the stems and catkins of various species of dwarf arctic willows. At present the natives often soak the tinder in a strong solution of gunpowder and water to make it quick; an older way was to mix powdered charcoal with it. This

[51] Journ. Anthrop. Inst., Great Britain and Ireland, vol. 7, p. 83.

[52] Lafitau. Moeurs des Sauvages Ameriquains, p. 272. An earlier account is found in Le Jeune, Relation de 1634, p. 24. Quebec, 1858.

[53] Journ. Anthrop. Inst., Great Britain and Ireland, vol. 5, p. 225.

plan is like the charring of the linen rags used in the old-fashioned tinder boxes of 40 years ago. The Eskimo then puts the tinder into a little round, flat pouch, with a flap in the middle. (Fig. 41, 1.)

The pyrites (fig. 42, 3) looks like a short pestle, to much of which appearance the repeated scraping has no doubt given rise. The upper end is concave, while the lower end has the original smooth surface of the concretion. Pyrite is found at Point Barrow in spherical masses of various sizes up to several pounds in weight. These spheres are nearly always cracked in two and scraped on the plane surface for very obvious reasons. This gives the shape seen in Fort Simpson and Long Barrows specimen. Mr. Murdoch says that the Eskimo think that pyrites comes down from above in meteors. They call it "firestone." A native related that in old times they did not use flint, but two pieces of pyrites, and got "big fire."

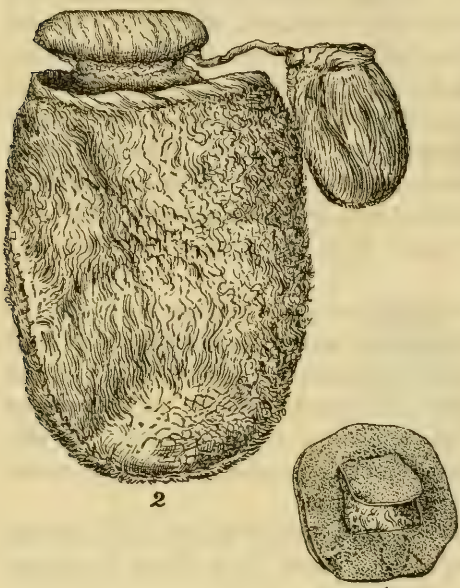
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Fig. 41.—1. Tinder pocket. 2. Fire bag. (Part of strike-a-light set.) Cat. No. 128405, U.S.N.M. Mackenzie River District, British Columbia. Collected by E. P. Herendeen

The flint (fig. 42, 4) is an oblong piece of chert, square at the base and rounded at the forward end. It is more elaborately made than the flakes so numerous in Europe, one of which was found with the piece of pyrites in the English Barrows. The Mackenzie River scraper is more like the curved ancient one. In most cases the flints used are not mounted in a handle; this specimen, however, is fixed in a handle made of two pieces of wood held together by a thong of seal skin. (Fig. 42, 4*a*.)

The bag (fig. 41, 2) is made of reindeer skin. The little bag that hangs from the larger has a double use; it is a receptacle for reserve tinder, but its chief use is for a toggle; being passed under the belt it prevents the loss of the outfit, which is said to be carried by the women.

An oblong pad, stuffed with deer hair, is sewed to the mouth of the firebag to protect the hand from sparks and blows of the flint.

To get a spark, the Eskimo places (fig. 43) the piece of pyrites on the pad held in the left hand over the curved forefinger, the large end down and the thumb set in the cup-shaped cavity in the top. The flap of the tinder pocket is turned back and held on the forefinger under the protecting pad. The flint is held in the right hand and by a scraping motion little pieces of pyrites at a dull red heat fall down into the tinder. The pellet that glows is transferred to the pipe or fire, and the flap of the tinder pocket is turned down, serving to keep the tinder dry and to extinguish it if necessary.[54]

There comes in here appropriately a note of B. R. Ross on the burial customs of the Kutchin Indians of the eastern Athapascan stock. He says:

> They bury with the dead a flint fastened to a stick, a stone to strike it on (pyrites) to make fire, and a piece of the fungus that grows on the birch tree for tinder and some touchwood also.[55]

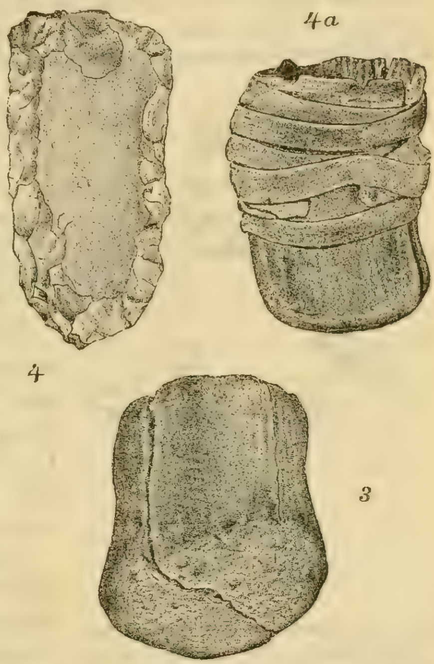

FIG. 42.—3. PYRITES. 4, 4a. FLINT STRIKER AND HANDLE. (PART OF STRIKE-A-LIGHT SET SHOWN IN FIG. 41.) CAT. NO. 128405, U.S.N.M. MACKENZIE RIVER DISTRICT, BRITISH COLUMBIA. COLLECTED BY E. P. HERENDEEN

There is no mention of this process of firemaking by the older writers of Greenland, Cranz and Egede, though they carefully note and describe the plan by wood boring. Later explorers going higher north in western Greenland have found it. Dr. Emil Bessels, writing about the Itah Eskimo of Smith Sound, says:

> The catkins of the Arctic willow are used as tinder to catch the sparks which have been produced through the grinding of two pieces of stone.[56]

Dr. E. K. Kane gives a more complete account from nearly the same locality, the Arctic Highlands of northwest Greenland. He says that the Eskimo of Anoatok struck fire from two stones, one a plain piece of angular milky quartz, held in the right hand, the other

[54] Extracted from an article by the author in Smithsonian Report, vol 2, 1888, pp. 181-184.
[55] Smithsonian Report for 1866, p. 326.
[56] Die amerikanische Nordpol-Expedition, p. 358. Leipzig, 1879.

apparently an oxide of iron [pyrites or iron ore ?]. They were struck together after the true tinder-box fashion, throwing a scanty supply of sparks on a tinder composed of the silky down of the willow catkins (*Salix lanata*) which he held on a lump of dried moss.[57]

Very much farther west on Melville Peninsula Parry gives a complete and interesting description of the primitive way. This account gives us a link between the western and eastern Eskimo. He writes:

For the purpose of obtaining fire the Eskimo use two lumps of common pyrites, from which sparks are struck into a little leathern case (see fig. 25, pl. LXXIV) containing moss well dried and rubbed between the hands. If this tinder does not readily catch, a small quantity of the white floss of the seed of the ground willow is laid above the moss. As soon as a spark has caught it is gently blown till the fire has spread an inch around, when the pointed end of a piece of wick being applied, it soon bursts into a flame, the whole process having occupied perhaps two or three minutes.[58]

FIG. 43.—METHOD OF USING THE STRIKE-A-LIGHT. CAT. NO. 128405, U.S.N.M. DRAWING BY W. H. BURGER

The Museum was in possession of a specimen catalogued, "Moss bag and lumps of pyrites used by Innuit for getting fire," collected by Capt. C. F. Hall at Pelly Bay, in latitude 69°, longitude 90°, several degrees west of Melville Peninsula.

The only other record of the process under consideration among the Eskimo is found in the Aleutian Islands. There is absolutely no evidence had by the writer that the Eskimo south of Kotzebue Sound (western Eskimo) use the pyrites and flint for making fire. The latest information about the Aleutian Islanders is given in a manuscript of the careful explorer, Lucien M. Turner. His observation will serve to explain the description of striking a light by earlier travelers.

They use the four part drill but they also use pyrites. A stone containing quartz and pyrites is struck against another similar one, or a beach pebble, into a mass of sea-bird down sprinkled with powdered sulphur. This ignites and is quickly caught on finely shredded blades of grass or beaten stalks of wild parsnips. This method prevails to this day on the islands west of Unalashka.

The people told Mr. Turner that this was the ancient way. There is a doubt in the writer's mind that Sauer's (Billing's Expedition, p. 59), and Campbell's (Voyage, p. 59,) observations, brought

[57] Arctic Explorations, vol. 1, p. 379.
[58] Second Voyage, p. 504. London, 1824.

together by Bancroft,[59] were accurate with regard to the stones used. All the other details are correct, but they say they took two pieces of quartz, rubbed them with sulphur, and struck them together. It is well known that pieces of quartz even when rubbed with sulphur will not strike a spark of sufficient heat to cause ignition. The pieces used must have been pyritiferous quartz as noticed by L. M. Turner.

To summarize, the following facts arise out of the foregoing considerations of the flint and pyrites method:

(1) It is very ancient, inferring from the few reliable finds of pyrites and flint in juxtaposition.

(2) Its distribution is among high northern tribes, both Eskimo and Indian.

(3) As far as known, its range is limited to this area, only one other instance coming to our notice, that of the Fuegians.

2. *Flint and steel.*—The flint and pyrites method is the ancestor of the flint and steel. The latter method came in with the iron age. It is found in the early settlements of that period. A steel for striking fire was found in the pile dwellings of the Ueberlingen See.[60] The Archeological Department of the Museum has a specimen of a strike-a-light of the early age of iron in Scandinavia. It is a flat, oval quartz stone with a groove around the edge; it is thought to be for holding a strap by which it could be held up and struck along the flat surface with the steel. It is scored on these surfaces. The specimen in the Smithsonian is from the national museum at Stockholm. In Egypt it is believed to have been used for a long period, though there is no data at hand to support the conclusion.[61] In China it has been in use for many centuries. Chinese history, however, goes back to the use of sticks of wood. The *briquet* must have been carried nearly everywhere by early commerce from the ancient countries around the Mediterranean, as it was into new lands by later commerce.

Many persons remember the tinder box that was taken from its warm nook beside the fireplace whenever a light was wanted; the matches tipped with sulphur used to start a blaze from the glowing tinder are also familiar to the older generation. The tinder boxes in use in this country were just like those in England from time immemorial down to 50 years ago. (Fig. 44.) Edward Lovett, of Croydon, England, who has studied this matter thoroughly, calls attention to the resemblance of the old English tinder flints to the neolithic scrapers. These scrapers, picked up at Brandon, can scarcely be discriminated from those made at the present time at that place, and there

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[59] Native Races of the Pacific States, vol. 1, p. 91.

[60] Keller. Swiss Lake Dwellings, pl. 28, fig. 29.

[61] Sir J. W. Dawson gives an interesting account of the strike-a-light flints used in Egypt in 1844, in Modern Science in Bible Lands, p. 30.

is a suspicion that the present tinder flint has come down directly from neolithic times. The old English steel, or "flourish" (fig. 44) is the characteristic shape, and has been carried by English commerce into many places. A picture of a strike-a-light used by the Lenguas of Brazil seen lately, shows the unmistakable old "flourish."

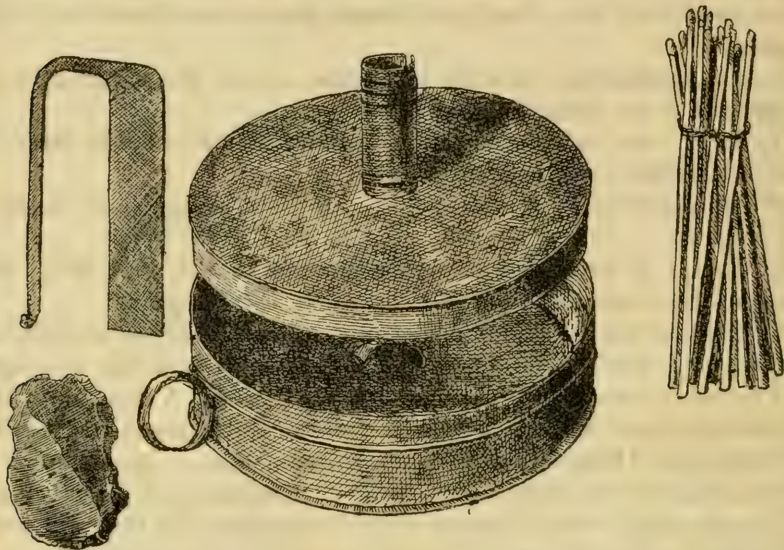


FIG. 44.—ENGLISH TINDER BOX (WITH FLINT, "FLOURISH," AND BUNDLE OF SPUNKS). CAT. NO. 75516, U.S.N.M. ENGLAND. COLLECTED BY LOUIS AND MAURICE FARMER

The tinder boxes had also a damper to extinguish the tinder of burnt linen and to keep it dry. The lids were furnished often with a candle socket. This feature, says Mr. Lovett, has led to their preservation as candlesticks long after they were superseded by matches.

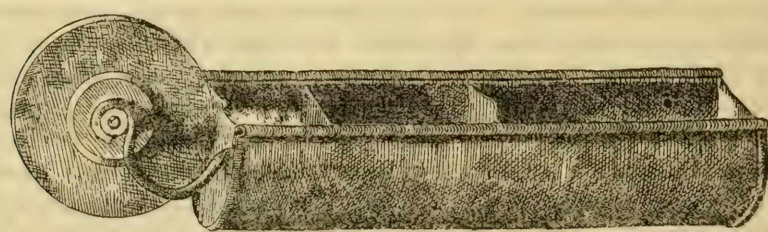


FIG. 45.—WHEEL TINDER BOX. CAT. NO. 130431, U.S.N.M. BROADALBIN, N.Y. PRESENTED BY F. S. HAWLEY

Many devices were invented in order to improve on the crude way of holding the flint and steel in the hands to strike the spark into the tinder box. One of these was the wheel tinder box. (Fig. 45.) The compartment near the wheel held the tinder. The flint was placed in a socket on the sliding lid and the wheel was turned by unwinding

a string from off its axle with a sharp pull as in spinning a top. The flint was pressed against the rapidly revolving wheel, and a shower of sparks fell into the tinder. The tinder pistol, whose name suggests its use, was another device.[62]

Other devices were intended to be carried in the pocket and were probably brought out by the introduction of tobacco and the need of smokers for a convenient light.

The pocket strike-a-light is still used. The one shown (fig. 46) was bought in 1888 by E. Lovett, at Boulogne-sur-Mer. They are still used by the peasants and workpeople of France. An old specimen in the Museum of this character is from Lima, Peru. The roll of tinder, or "match," is made of the felt lining of an ant's nest (*Polyrachus bispinosus*).

Among many of our North American tribes the flint and steel superseded the wooden drills as effectually as did the iron points the stone arrowheads.

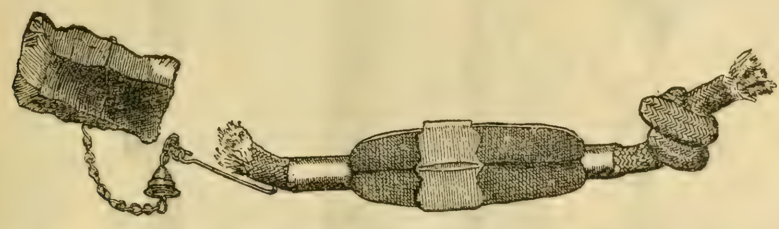


FIG. 46.—STRIKE-A-LIGHT (BRIQUET). (CAT. NO. 129693, U.S.N.M. BOULOGNE-SUR-MER. FRANCE. COLLECTED BY EDWARD LOVETT)

Some of these tribes were ripe for the introduction of many modern contrivances. Civilized methods of fire lighting appealed to them at once. Among the Chukchis, Nordenskiöld says, matches had the honor of being the first of the inventions of the civilized races that have been recognized as superior to their own.[63] It was so among our Indian tribes; the Mandan chief "Four Bears" lighted his pipe by means of a flint and steel taken from his pouch when George Catlin visited him in 1832.[64]

The Otoes (Siouan stock) made use of the flint and steel shown in Figure 47. The flint is a chipped piece of gray chert, probably an ancient implement picked up from the surface.

The steel is a very neatly made oval, resembling those of the Albanian strike-a-lights,[65] or the Koordish pattern. (Fig. 52.) Here arises one of the perplexities of modern intercourse; perhaps both of these steels were derived from the same commercial center.

[62] See figure in D. Bruce Peebles's address on Illumination, in Trans. Roy. Scottish Society of Arts Edinburgh. vol. 12, pt. 1, p. 96.

[63] Voyage of the *Vega*, vol. 2, p. 122.

[64] The George Catlin Indian Gallery. Smithsonian Report for 1885, vol. 2, p. 456

[65] See figure in Journ. Anthrop. Inst., Great Britain, vol. 16, 1886, p. 67.

The flint, steel, and tinder were always carried in a pouch, usually suspended from a belt as in specimen No. 8481 from the Assiniboins (Siouan stock) of Dakota. This is a buckskin waist belt, beaded and fringed, ornamented with bells of tin. It supports a flapped pouch for the flint, etc. The tinder used was fungus.

The pouch of the Cheyennes (Algonquian stock) is compact, and neatly made of leather. (Fig. 48.) The equipment is complete and of a superior order. The bone cup is used to hold the tinder while striking a spark into it. It is the tinder horn of early days, a cow's horn which was used to hold tinder before sheet-iron boxes came into

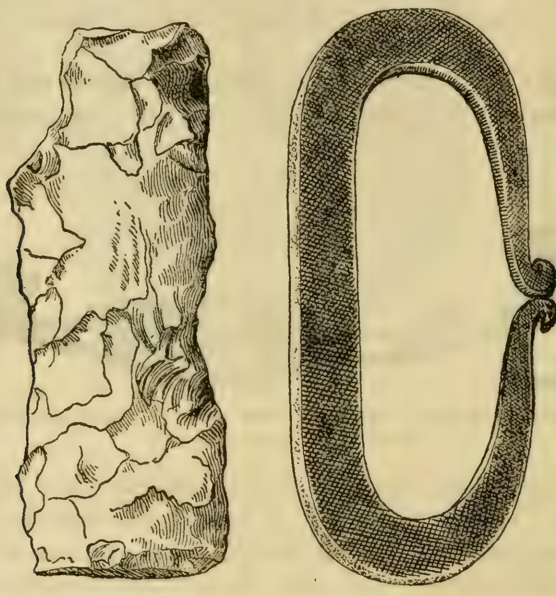


Fig. 47.—Flint and steel. Cat. No. 22431, U.S.N.M. Otoe Indians, Kansas and Nebraska. Collected by J. W. Griest

use. The Lenguas of Brazil use a horn for the same purpose.[66] In the Aino set (fig. 54) can be seen this feature. The tinder with this set is rotten wood. Nearly all Indians know the value of fungus tinder.

The Comanche Indian strike-a-light is a similar pouch to the one described, but much poorer in equipment. (Fig. 49.) A broken rasp, a piece of chert, and a piece of spunk is enough for the purpose, and a bag made from a saddle skirt to hold them completes the outfit.

The flint and steel is still used nearly all over Mexico, Doctor Palmer informs me. There is at present a manufacture of gun and strike-a-light flints at Brandon, England, whence they are shipped to Spain, Mexico, Italy, and other civilized countries. Doubtless this

[66] See figure in Jahrbuch Mittelschweiz. Commercial. Gesellsch. Arau, vol. 2, 1888, pp. 114–115.

flint from Guadalajara (fig. 50) came from Brandon. It is real calcareous flint, such as does not exist in this country. The steel is the "swallowtail" pattern. The tinder is of prepared fungus sold in little packets.

FIG. 48.—STRIKE-A-LIGHT (FLINT, STEEL, TINDER HORN, SPUNK, AND POUCH). CAT. NO. 22104, U.S.N.M. CHEYENNE INDIANS, ARKANSAS. COLLECTED BY DR. J. H. BARRY

The Koords of Bhotan, eastern Turkey, carry a pipe pouch containing besides flint, steel, and tinder, a pipe pick and a pair of pincers, to transfer the lighted tinder to the pipe. (Fig. 52.) The tinder is prepared from a fungus, probably a species of *polyporus*. The

steel, shaped like an old-fashioned bell pull, is a very good form for holding in the hand.

The Chinese strike-a-light is the customary appendage to the pipe pouch. It is a very ingenious way for combining the steel with a

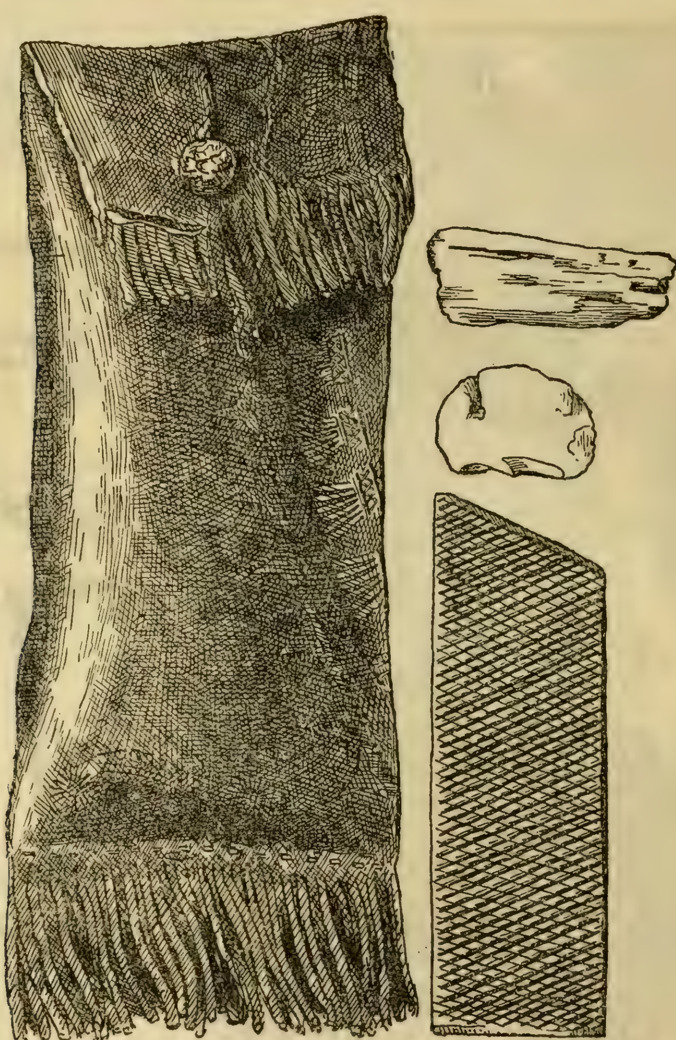


FIG. 49.—STRIKE-A-LIGHT. (POUCH FOR HOLDING FLINT AND STEEL.) CAT. NO. 6972, U.S.N.M. COMANCHE INDIANS, TEXAS. COLLECTED BY EDWARD PALMER

pouch in which to keep the flint and tinder. (Fig. 51.) In Tibet they are made very large and are finely decorated. One owned by Mr. W. W. Rockhill has a curving steel between 5 and 6 inches long, finely carved. The pouch was trimmed with encrusted silver set with jewels.

The Ainos of Japan use flint and steel for striking a light, this method having supplanted the generation of fire by sticks (p. 26.) This outfit shown (fig. 54) is complete. The shoe-shaped steel

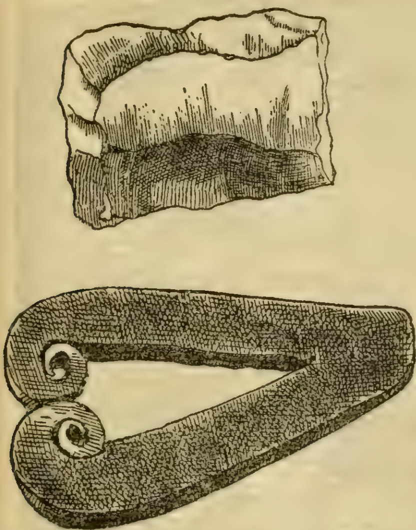


FIG. 50.—FLINT AND STEEL. CAT. NO. 126576, U.S.N.M. GUADALAJARA, INDIANS, MEXICO. COLLECTED BY EDWARD PALMER

FIG. 51.—STRIKE-A-LIGHT. CAT. NO. 130311, U.S.N.M. CHINA. GIFT OF GEORGE G. FRYER

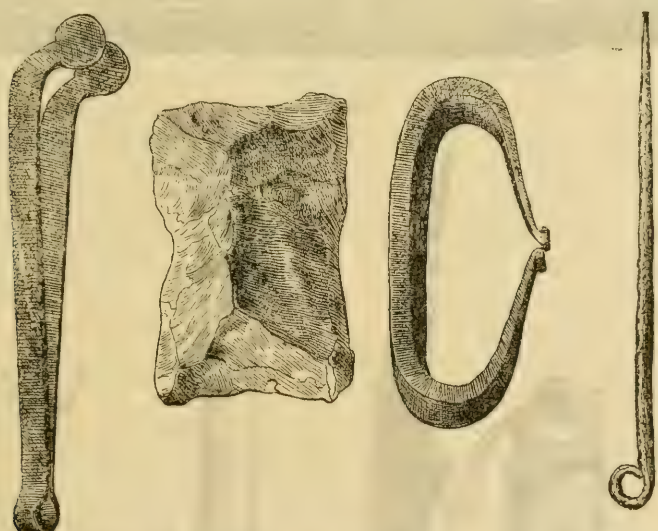
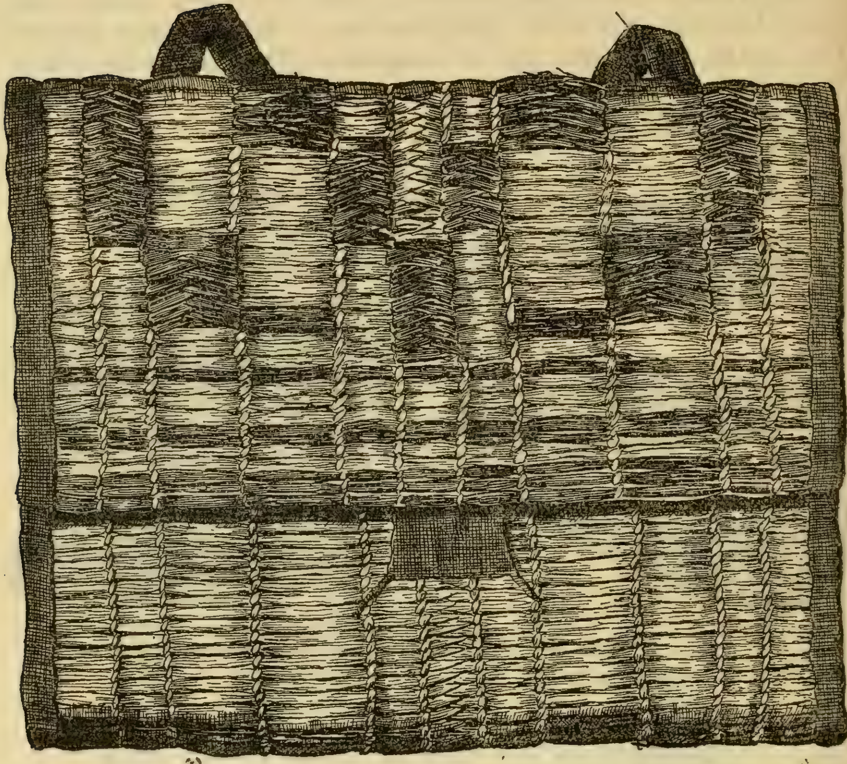


FIG. 52.—SMOKERS' PIPE-LIGHTING OUTFIT SHOWING FLINT, STEEL, PIPE PICK, AND PINCERS). CAT. NO. 130607, U.S.N.M. KOORDS OF BHOTAN, EASTERN TURKEY. COLLECTED BY REV. A. N. ANDRUS.

is attached by a piece of sinew to the cork of a small wooden bottle containing the soft charcoal used as tinder. The flint is a small piece of ferruginous silex. With this set is a piece of stick which



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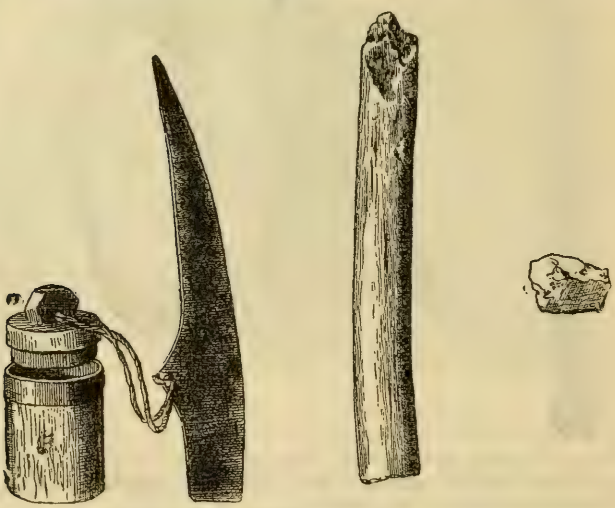


54

FIGS. 53-54.—53, RUSH FIRE SET POUCH. 54, STRIKE-A-LIGHT. FLINT, STEEL, AND TINDER BOX. CAT. NO 22257, U.S.N.M. AINOS OF YEZO, JAPAN. COLLECTED BY B. S. LYMAN

retains fire for a long time. It is the root of the *Ulmus campestris*, or *laevis*, formerly used for the fire drill, but has come into a secondary place since the introduction of the flint and steel.

To strike a light the Aino takes out the cork with the steel attached and stirs up the tinder with the sharp point. He then holds up the flint in his hand over the box and strikes a spark down into it. He then transfers the coal to his pipe, or material for fire, or fire stick, with the point of the steel. These articles are kept in a rush pouch of twined weaving. (Fig. 53.) A much ruder pouch of fishskin is in the Museum.

The Japanese tinder box has two compartments, one with a damper for the tinder and the other larger one for the flint and steel. This box is a familiar object in Japanese kitchens. The mounting of the steel in wood is an improvement on holding it between the fingers. (Fig. 55.) No one, it seems, ever thought of so mounting the steel in western countries. The matches are broad shavings tipped at both ends with sulphur, and are the Japanese rendering of the "spunks" used with our tinder box.

Smokers in Japan carry a very small strike-a-light. (Fig. 56.) The cloth pouch with a long flap that can be rolled around several times and tied contains the three essentials, flint, steel, and tinder, the latter of burnt cotton.

3. *On bamboo*—Under percussion is classed the bamboo and porcelain strike-a-light first described by Sir Alfred Russell Wallace as used by the natives of Ternate, Malay Archipelago. Sir Alfred remarks that the Ternate people make great use of bamboo in their daily life and describes a particular method by which fire is struck from the flinty surface of the bamboo with a small piece of broken china, producing a spark which is caught on tinder. This apparatus vies with the fire piston as fire-making curiosities. Necessarily the method is confined to the bamboo area strictly, but has never been found in the Western Hemisphere. The bamboo selected and from which the specimens in the United States National Museum are made has a rough surface layer feeling like fine sandpaper. This coating is in the form of a flinty layer about one-half millimeter thick which is chipped away in small bits under the stroke of the china. The material of the layer is probably a combination of silica with some organic substance rendering it capable of taking up the force of the blow and converting it into heat sufficient to ignite tinder. The specimens in the Museum consist of a joint of bamboo or cane, a tinder box of bamboo with cap lid, and hooped with braided rattan. A cord passes through holes at the bottom, through holes in the cap, and forms a loop to pass around the bamboo joint. Some of the Battak tinder boxes are decorated with incised patterns. The Battak specimens usually have two tinder boxes.

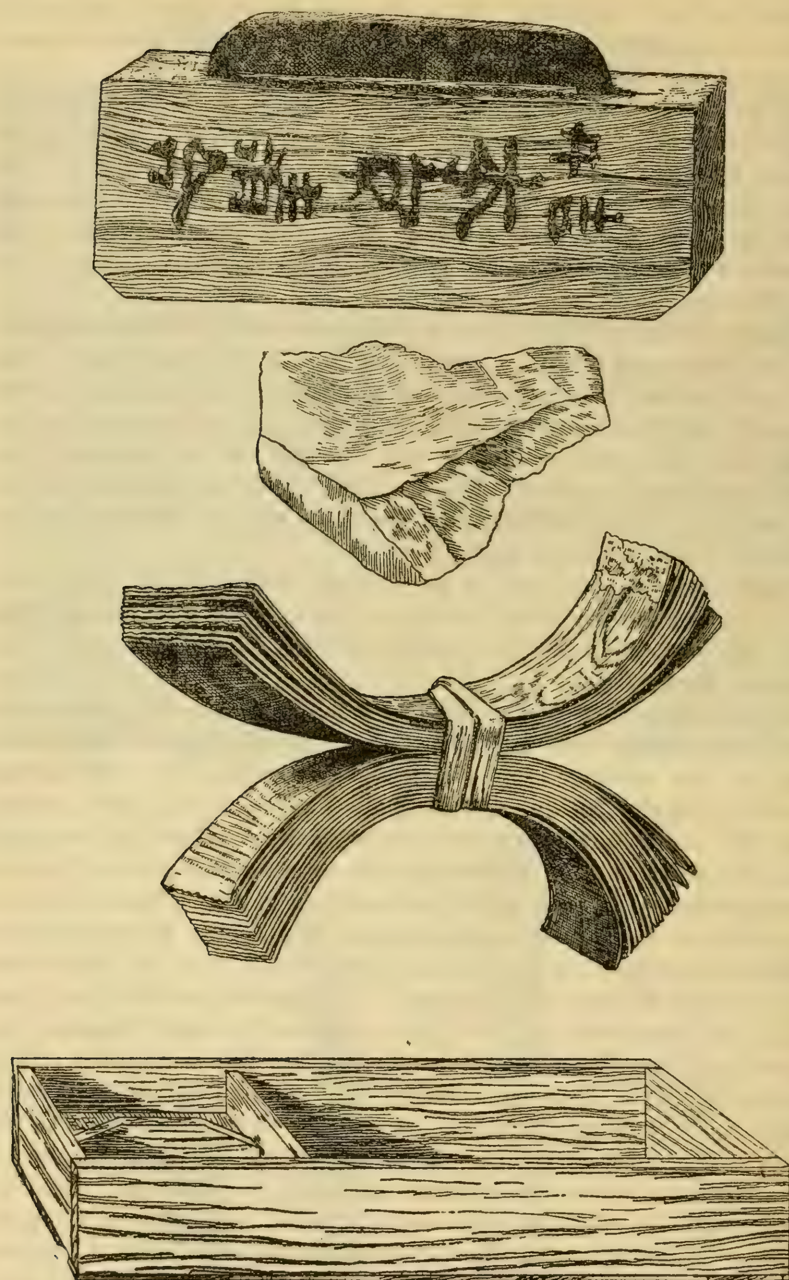


FIG. 55.—TINDER BOX (SHOWING MOUNTED STEEL, FLINT, AND BUNDLE OF SHAVING MATCHES; BOX ONE-THIRD NATURAL SIZE). CAT. NO. 127137, U.S.N.M. JAPAN. GIFT OF THE JAPANESE DEPARTMENT OF EDUCATION, TOKIO

The specimens are as follows:

Cat. No. 326011, a set from the Battaks of Palawan, collected by Capt. E. Y. Miller. The bamboo tube is 14 inches long (35.5 cm.), three-fourths inch deep (2 cm.); the boxes are 5¼ inches long (13.5 cm. and 3.1 inches deep (5.25 cm.). (Pl. 10, fig. 1.) One of the boxes contains tinder and a bit of flint. Cat. No. 326012, Battaks, Palawan, P. I. Mrs. F. G. Miller has a bamboo tube 17.6 inches long (44.5 cm.), 1 inch deep (2.6 cm.). One tinder box is 5.5 inches long (14 cm.) and 1.7 inches deep (4.5 cm.). The box contains tinder and a piece of flint. (Pl. 10, fig. 4.) Cat. No. 232283, Malays of Balabac, an island south of Palawan, P. I.; collected by Capt. E. Y. Miller. Captain Miller has two tinder boxes not matched as to size. The bamboo tube is 17.45 inches long (44 cm.), 1.1 inches deep (2.5 cm.). The larger tinder box is 7 inches long (18 cm.), 2.4 inches deep (6 cm.). (Pl. 10, fig. 2.) The tinder is brown and appears to be the scurf of a palm. The striker is a gunflint. Two well-decorated tinder boxes brought from Palawan by Captain Miller are Figure 3, Plate 10, and measure 5.5 inches long (14 cm.), 2.4 inches deep (6 cm.); 5.5 inches long (14 cm.), 2 inches deep (5 cm.), Cat. No. 326013.

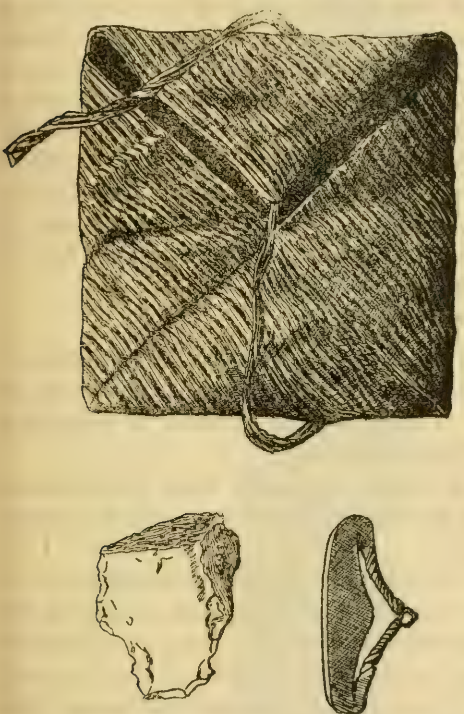


FIG. 56.—SMOKERS' STRIKE-A-LIGHT. CAT. NO. 128138, U.S.N.M. TOKIO, JAPAN. GIFT OF THE JAPANESE DEPARTMENT OF EDUCATION

Plate 9, Figures 1, 3, show boxes open exposing tinder. Above Figure 3 is a pistol flint found in one of the boxes. Ordinarily a bit of broken dish is employed, since flint is not local in a vast Pacific area.

There is evidence that the bamboo strike-a-light had a considerable range in Malaysia, and notices of it have come from Cochin China, southern Philippines, Ternate, and Waigiou, an island off the northwest point of New Guinea, all on a line running southeast from Cochin China.

V. BY COMPRESSION OF AIR

The fire syringe, as it is called, consists of a piston and plunger. Generally the piston is a smooth circular canal drilled in hardwood or horn. The plunger fits the cavity with exactness. In practice a bit of tinder is placed in a slight cavity at the end of the plunger; the latter is set in the orifice and driven down with a sharp blow. Quickly withdrawing the plunger the tinder is found alight.

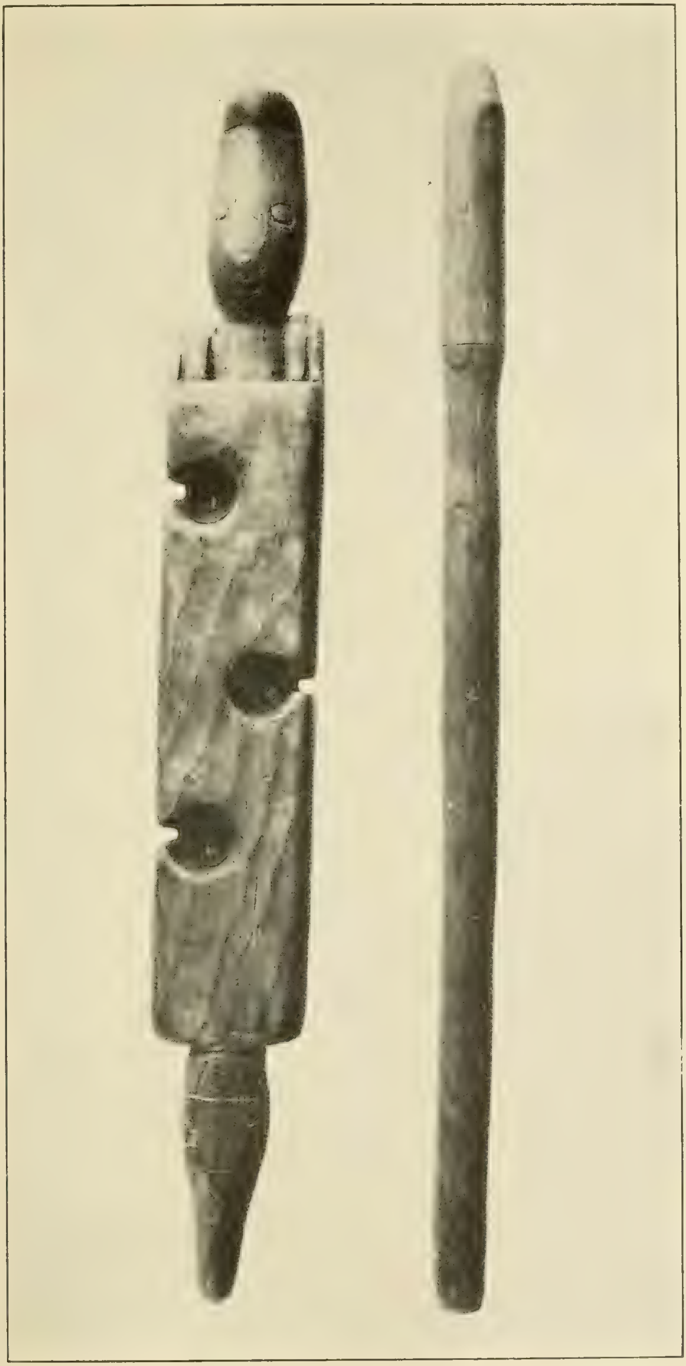
The principle is that in being compressed to a smaller volume air gives up heat. In the case of the fire syringe this is enough to ignite tinder. This is a method which has been employed by many tribes of men in Malaysia, and it appears to be a native invention. Plate 11 shows three specimens from various parts of the Philippines, Figures 1, 3, and 4, Cat. No. 235261, Mindoro, Philippine Commission; 5 inches long (12.5 cm.); Cat. No. 215659, Luzon, Dr. Charles E. Woodruff, United States Army, 3½ inches long (10.75 cm.); Cat. No. 216736, Luzon, Col. F. F. Hilder, 5 inches long (13 cm.). Figure 2 is of horn, Cat. No. 176007, Lower Siam, Dr. W. L. Abbott, 3.5 inches long (9 cm.). Figure 5 is of hard palm. Cat. No. 175270, Java, M. F. Savage, 8½ inches long (21 cm.).

VI. TINDER

It is no doubt true that acquaintance with tinderlike substances was forced on man by the behavior of the camp fire in consuming at different rates such material. Tinder is also implied in preparing and arranging the fuel for starting a new fire.

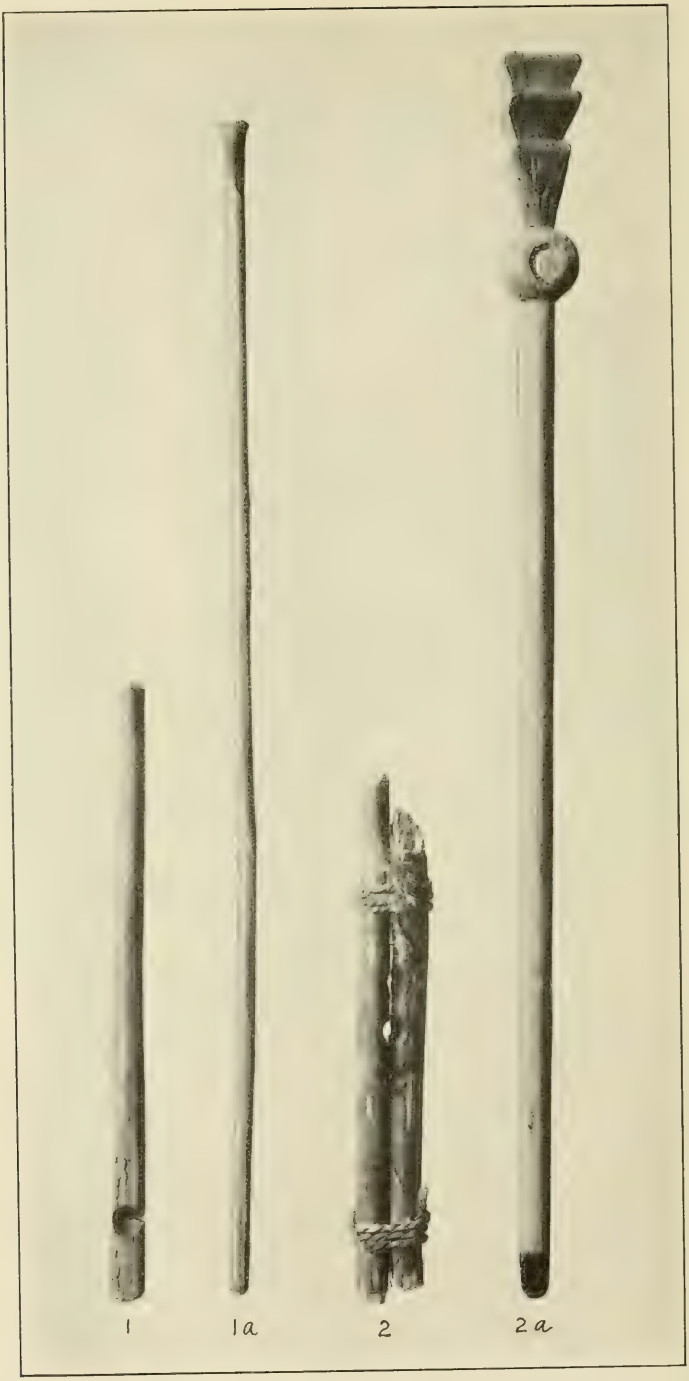
From these considerations it seems probable that this feature involved in the invention of the fire drill had been prepared in a measure long previously.

The collection of tinder in the Museum is almost exclusively of vegetal substances, but in many cases these have been improved by the addition of charcoal, gunpowder, and niter. Animal substances are necessarily rare and so far as observed consist of the down of birds and the nest lining spun by an ant (*Polyrachis bispinosus*), the latter from South America. Vegetal substances used as tinder are classified as follows: (*a*) Bark, especially the outside spent layers of trees with stringy bark in the first stages of decay; (*b*) scrapings of inflammable wood; (*c*) scurf down from leaves and about the flowering areas of certains plants; (*d*) downy catkins or down from seed heads out of bloom; (*e*) dry leaves rubbed fine or grass treated in the same manner; (*f*) rotten wood also used for retaining fire; (*g*) fungi, either natural as in the sheet fungi or worked into condition for use as by boiling in solution of potassium nitrate or saltpeter; (*h*) imperfectly charred cotton or linen cloth or thick, soft cords impregnated with a chemical. The Chinese use soft paper prepared in a similar manner. The Japanese so far as known are unique in using mixed tinder composed of several of the substances mentioned above.



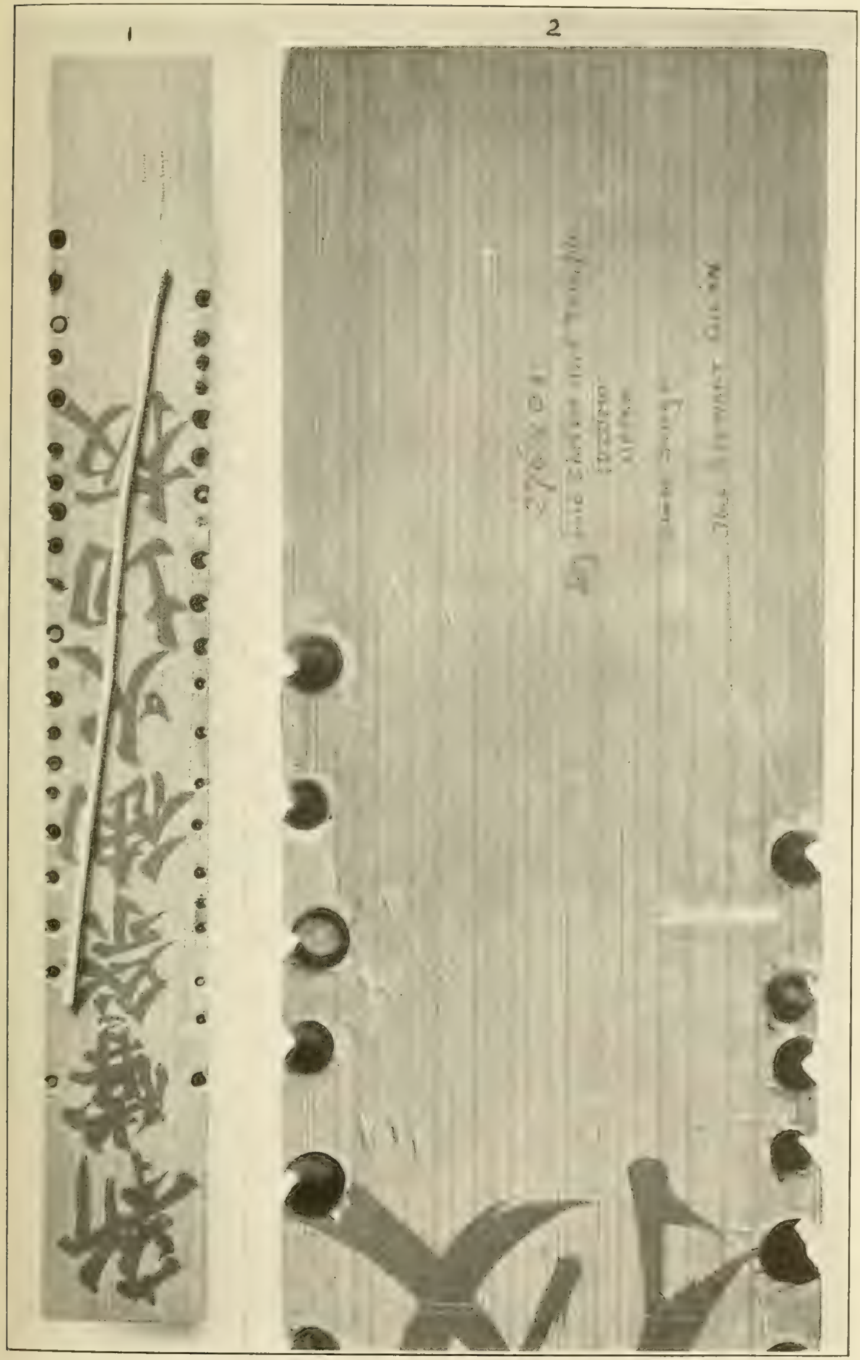
SOUTHERN TLINKIT DRILL

FOR DESCRIPTION OF PLATE SEE PAGE 11



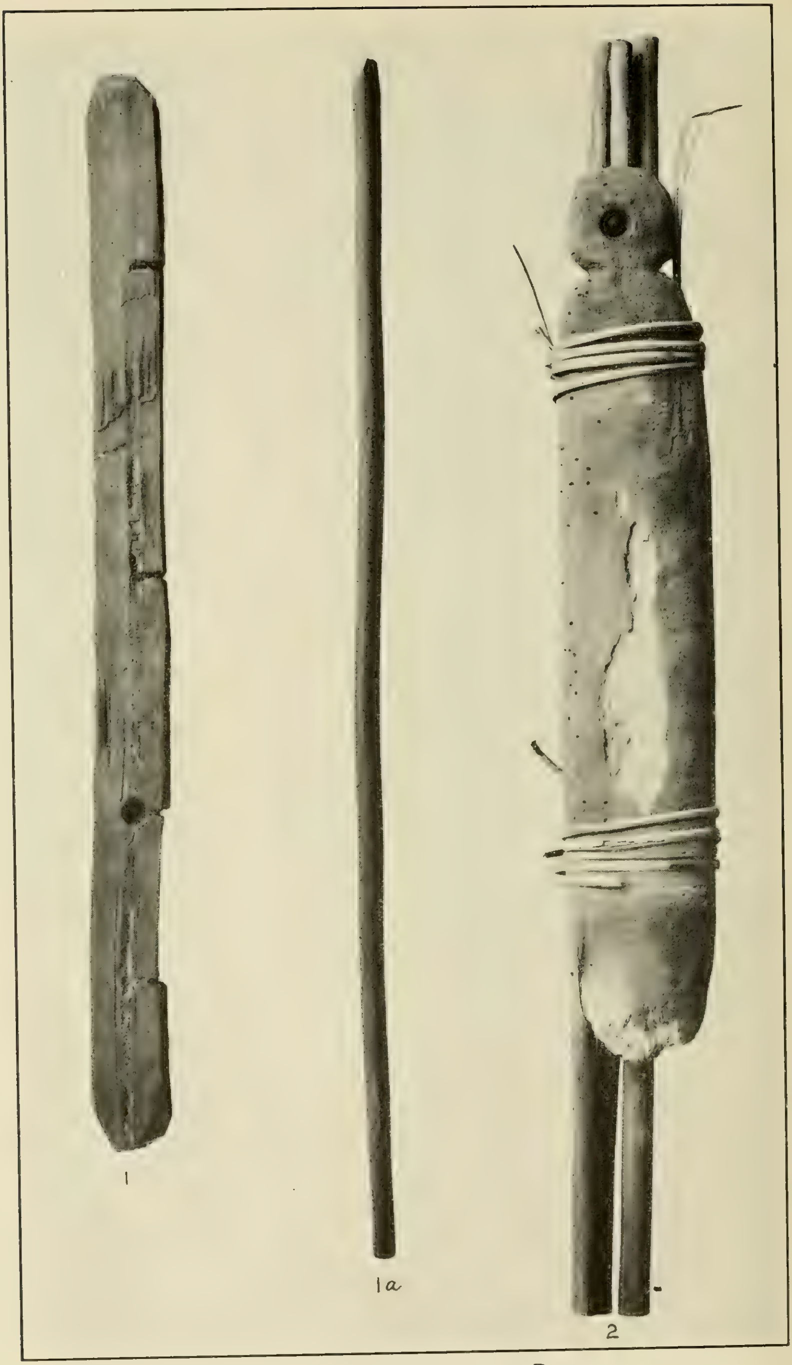
BRITISH GUIANA, WEST INDIAN, AND MEXICAN DRILLS

FOR DESCRIPTION OF PLATE SEE PAGES 21, 22, AND 25



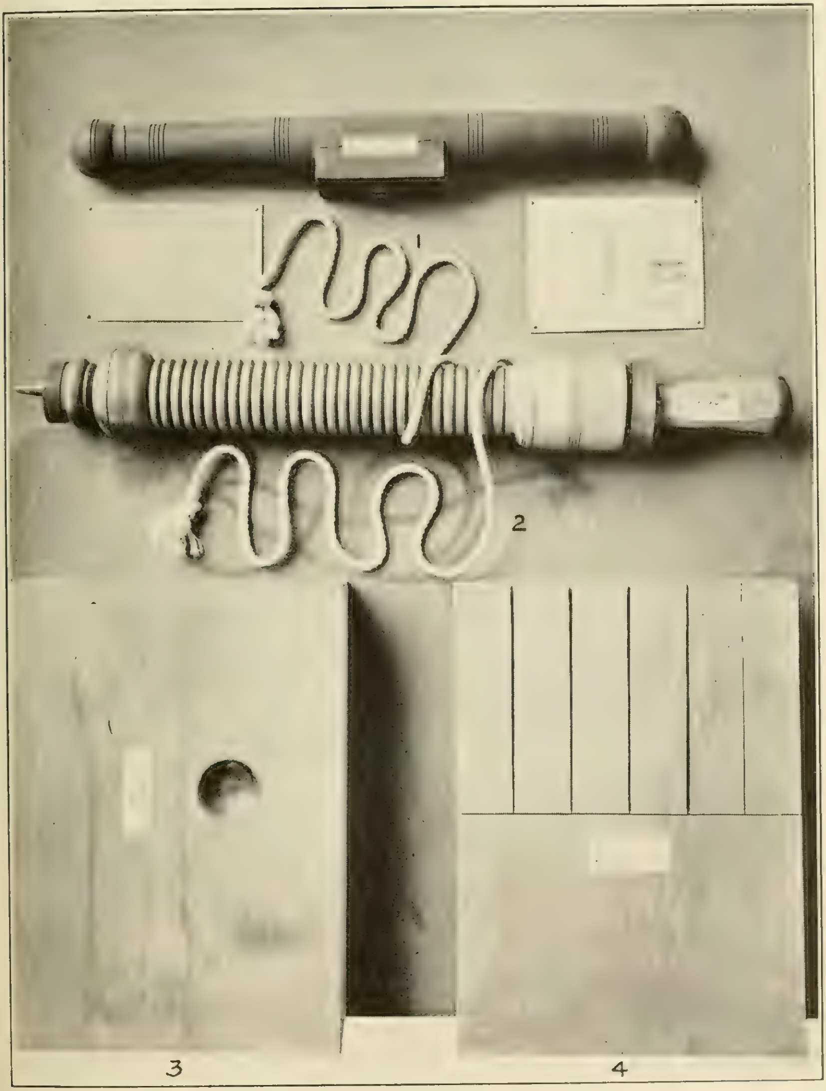
JAPANESE SACRED FIRE DRILL, FULL VIEW AND SECTION

FOR DESCRIPTION OF PLATE SEE PAGE 27



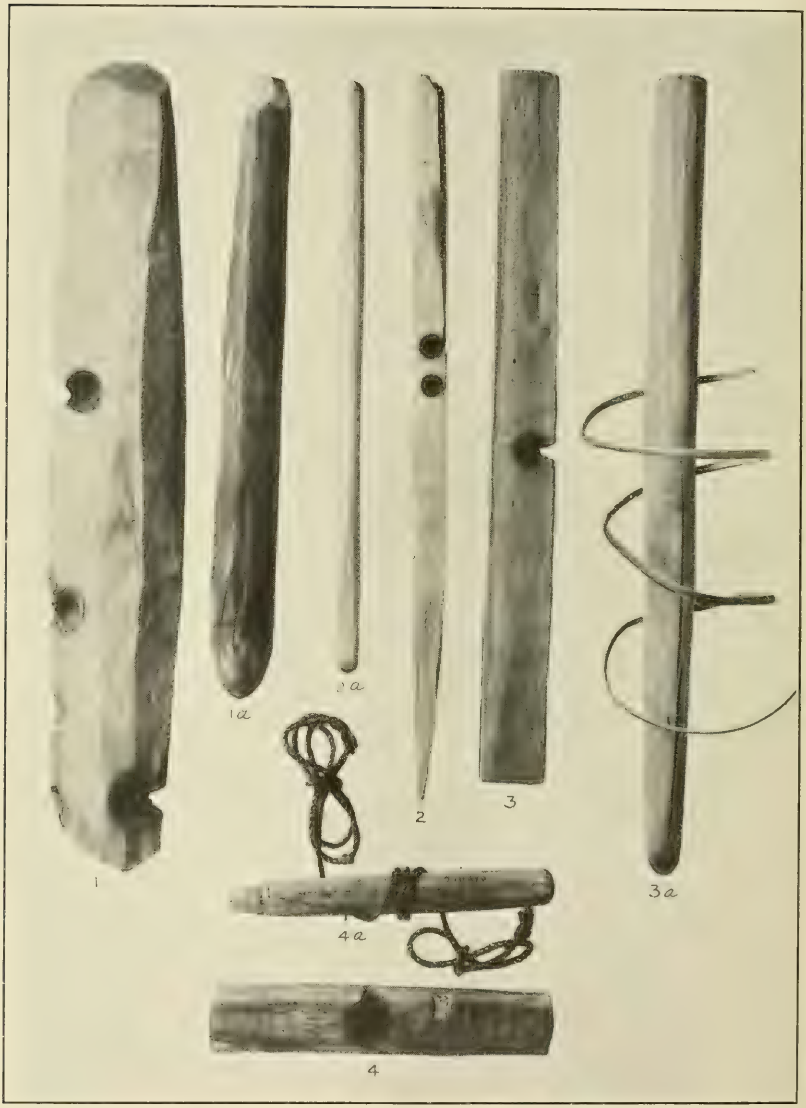
BHILS, INDIA, AND AUSTRALIAN DRILLS

FOR DESCRIPTION OF PLATE SEE PAGE 28 AND 32



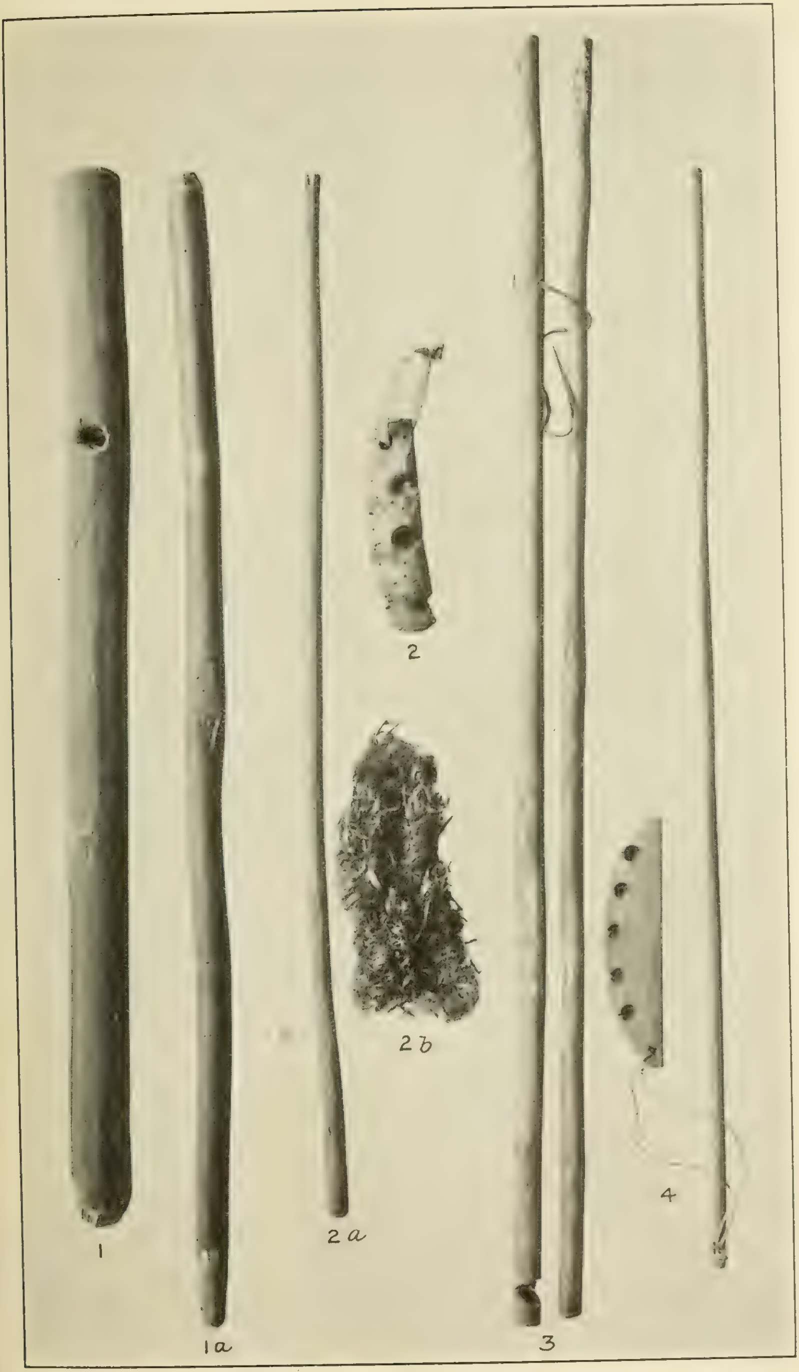
HINDU SACRED FIRE DRILL (REPLICA)

FOR DESCRIPTION OF PLATE SEE PAGE 29



EAST INDIAN FIRE DRILLS

FOR DESCRIPTION OF PLATE SEE PAGE 30

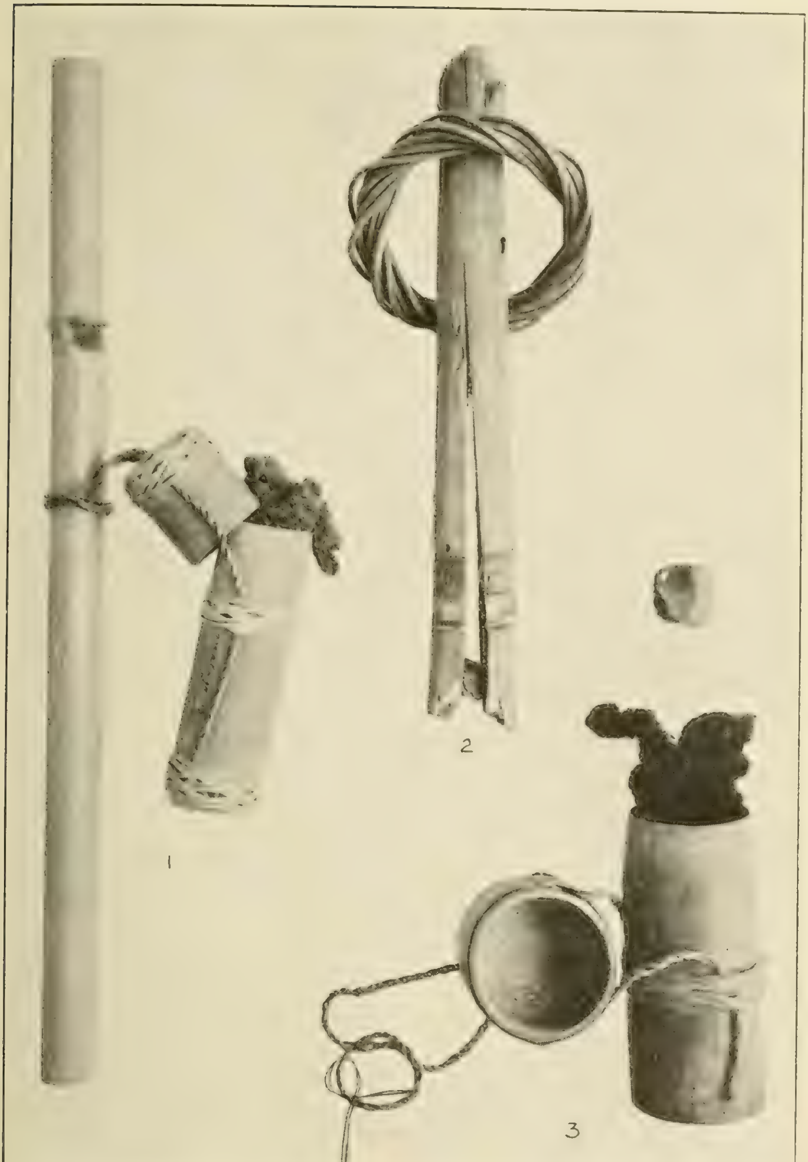


AFRICAN FIRE DRILLS

FOR DESCRIPTION OF PLATE SEE PAGE 31

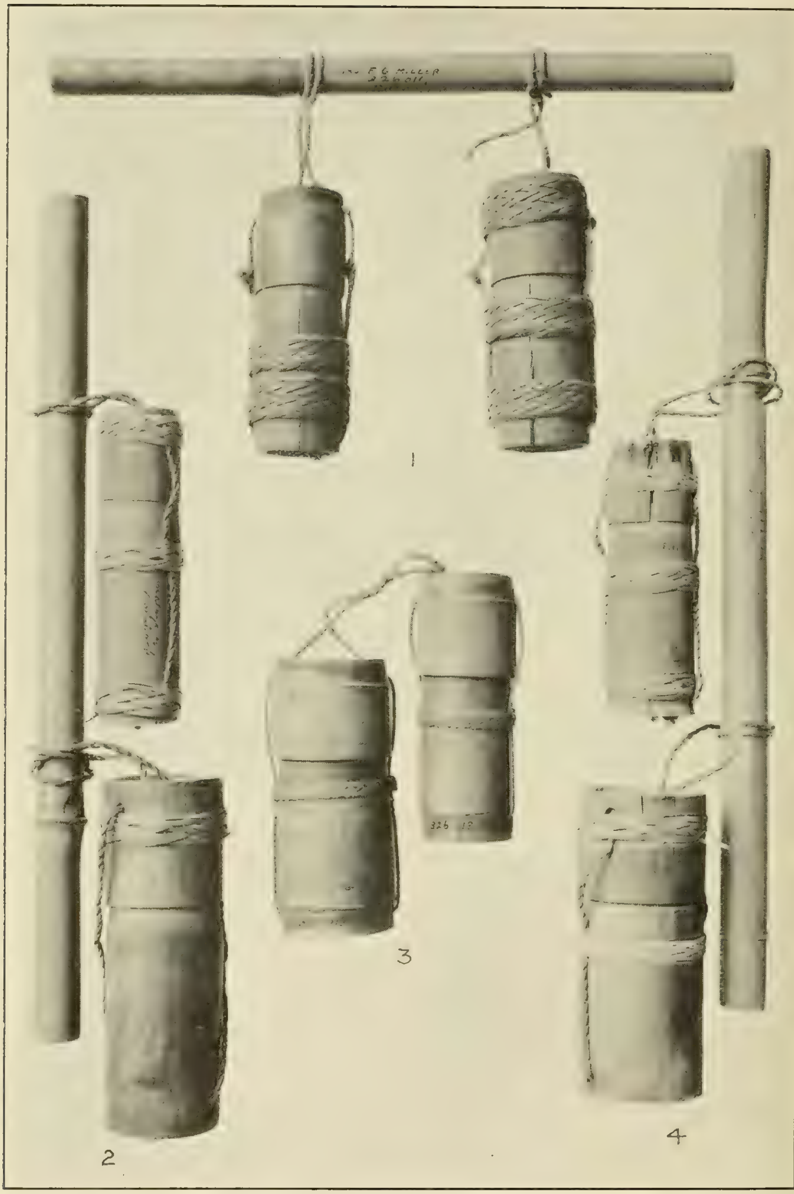
BAMBOO FIRE SAW, PHILIPPINES

FOR DESCRIPTION OF PLATE SEE PAGE 52



BAMBOO STRIKE-A-LIGHTS AND BATTAK (NEGRITO) FIRE THONG

FOR DESCRIPTION OF PLATE SEE PAGES 30, 55, 71



BAMBOO STRIKE-A-LIGHTS, MALAYSIA

FOR DESCRIPTION OF PLATE SEE PAGE 71

FIRE PISTONS, MALAYSIA

FOR DESCRIPTION OF PLATE SEE PAGE 72

CONTRIBUTION TO THE COMPARATIVE ANATOMY OF THE EARED AND EARLESS SEALS (GENERA ZALOPHUS AND PHOCA)

By A. Brazier Howell,
Collaborator, United States National Museum

FOREWORD

The interest of anatomists has long been intrigued by the Pinnipedia and it is probable that no order of a comparable size has been more often investigated from this standpoint. The pinnipeds have a very important place in the program of the author relative to his investigation of aquatic adaptations in mammals and he at first thought that this work with the order would be rendered relatively easy by the apparently full reports upon both the myology and osteology, illustrated in some cases by handsome plates, with which he was casually acquainted. Only a little investigation was needed, however, to establish the fact that these reports were not of great aid, for they are chiefly descriptive, and many discrepancies were apparent.

Of the earlier dissections of pinnipeds those by Duvernoy (1822), Humphrey (1868), and Lucae (1873) are all important, although some of their details are to be viewed with suspicion and many of their conclusions are extremely unlikely. But scant attention need be paid them in the present report, however, for their details are well incorporated in the paper of W. C. S. Miller (1887), who discusses them with really unnecessary fullness, and their inclusion here would not only constitute repetition, but would be otherwise undesirable as befogging the report to a bewildering degree. Comparisons have therefore been made only with the findings of Miller and Murie, where these investigators differ from conditions as encountered by me. Miller was an accomplished anatomist who dissected a variety of pinnipeds, presumably with great skill. His text treats fully of a *Phoca vitulina* and an *Arctocephalus*, although comparisons are made where desirable with several other phocids and an *Otaria* (=*Eumetopias*). A serious defect, however, is that his report is unillustrated as far as concerns the musculature, and his de-

scriptions are often so involved and bristling with details, unimportant save when a study is being made of individual variation, that one is often at a loss to fathom his exact meaning. He made some mistakes in interpreting what he saw, and doubtless others which it is difficult to discover, but one gathers the impression from working with his paper that he was a capable, trustworthy man, doing work of a high order of merit.

Murie's reports upon the myology of *Eumetopias* (his *Otaria*) (1872) and *Odebenus* (his *Trichechus*) (1870) are descriptive rather than comparative. They are accompanied by beautiful plates some of which are far more satisfactory than any I could execute, but others are vague and misleading. He misnames and misinterprets a number of muscles, although to but a slightly greater extent than did Miller. It is, of course, beyond question that Murie was an able and brilliant human anatomist, but it is perhaps not out of place for me to say that after working with his sea lion and *Globiocephala* reports line by line I have received a definite impression that implicit reliance can not always be placed upon the myological details which he presents.

One might, therefore, justifiably enquire regarding the value of an additional report upon the anatomy of the Pinnipedia. The reason is that the others are largely descriptive or compare individual muscles, but no one has heretofore analyzed the differences occuring in the otariids and phocids, the significance of these from a functional aspect, the reasons for the osteological peculiarities, and the organization of the pinniped as a dynamic machine built for aquatic locomotion. My myological report is but a necessary part of the whole. The conclusions to which the anatomical evidence points has not been discussed in entirety, however. Most of the myological discussion is presented with the muscles, some of the osteological with the bones, and still more under the general discussion. Yet additional facts and theories are being reserved which are considered to belong more properly with a comparison of the Pinnipedia with other aquatic mammals. I have placed those interpretations upon the anatomical peculiarities of the Pinnipedia which to me seem most logical, but it can not be claimed that all of these are correct, or that some of them will not need modification when additional facts are brought to light.

In the drawings of muscles no especial system of reduction is used, the proportions being merely such as will fit conveniently upon a page. In the bone drawings, however, comparative details are presented to represent relative difference in size, and because the trunk length of the *Phoca* skeleton used in comparisons was seven-tenths that of the *Zalophus*, the reduction of the latter's bones is but seven-tenths of those of the former. In this way one may more readily compare osteological details.

HABITS

For a proper understanding of the pages that follow it will be necessary briefly to discuss the habits of the eared and earless seals, and to mention certain acts which their form allows them to perform or prevents them from doing.

Zalophus californianus, as representing the sea lions or eared seals, is fundamentally a long, rather slender animal, save when very fat or in the case of mature bulls, which spend considerable time on land but seldom venture farther than a few yards away from the sea. The fore and hind limbs are both highly modified into paddles and considering the highly specialized condition in this respect, terrestrial locomotion is accomplished with more agility than one would imagine

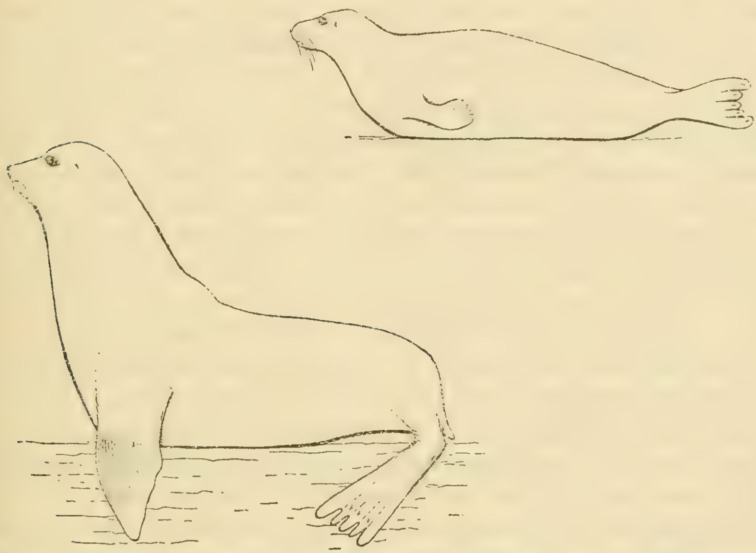


FIG. 1.—TYPICAL TERRESTRIAL POSTURES OF AN EARED SEAL (SEA LION OR OTARIID, ZALOPHUS) AND EARLESS SEAL (TRUE SEAL OR PHOCID, PHOCA, ABOVE)

to be possible, and the animal travels on land much as would a fissiped carnivore with legs of equal length, galloping about with considerable speed. The neck is extraordinarily mobile, enabling a trained sea lion to perform surprising feats of balancing with its nose, probably to a more perfect degree than could any terrestrial mammal. Marked flexibility of the lumbar region also exists, and otariids—especially fur seals—can contort this part of the back in a striking manner. The forelimb is used as the primary and almost exclusive means of aquatic locomotion, and as the chief support for the body when on land. In the latter situation the manus is bent at the wrist and extended laterad. The pes is also bent at a right angle to the shank, but as the shin is bound down to the pelvis, so as

to be held within the body contour and virtually immovable, the only way that the foot can assume the plantigrade position used in walking is for the sacral vertebrae to be forced into a position that is practically vertical to the ground, which is done with ease. The hind limbs apparently play a much less important part in swimming than one would infer from the degree of specialization which they exhibit.

The *Phoca hispida*, as typifying the earless seals or phocids, is really a very different animal. It, too, is stream line in form but in a somewhat different manner from the otariid. Usually fat, it is of greater circumference than the otariid of the same mass, excepting adult bulls of the latter, and in most forms at least is relatively shorter. The shortness of the neck seems especially marked and to a greater degree than is actually the case, for it is very wide, tapering to the broad thorax. The neck is not markedly flexible, as is that of the otariid—in fact, it is probably less so than in the average fissiped, and one gains the impression that the entire trunk is less agile than in the sea lion. The forelimbs are weak, are not used as a primary means of propulsion through the water but in lateral, water-treading movements, and their use on land is limited to such acts as aiding in the surmounting of a low obstruction. Swimming is accomplished by a rhythmic, transverse movement of the hind feet, presented palm to palm, the movements being on the whole comparable to those of a fish in swimming. Both otariids and phocids may swim for considerable distances on the back, but the former assumes this position evidently for brief periods only, while the latter is more prone to do so, at least in captivity. For several anatomical reasons, as discussed later, the Phocidae can not place the hind foot to the ground in a plantigrade manner and apparently never attempt to do anything with the feet while on land save keep them, palm to palm, elevated well out of harm's way. Terrestrial progression is accomplished by a caterpillarlike wriggling in the sagittal plane—not in the horizontal or transverse one—with the forefeet close to the sides and the hind ones elevated above the ground.

MATERIAL

The material assembled for the present work was not all that was desired but was the best that could be procured. As representing the Phocidae an embalmed subadult female of *Phoca hispida* taken by H. C. Raven, Ponds Inlet, Baffin Island, August 30, 1926, was obtained by exchange from the American Museum of Natural History. But a single skeleton, partially articulated, of this species could be located and that was borrowed from the Museum of Comparative Zoölogy through the courtesy of G. M. Allen. It is of a

subadult, unsexed, and bears the number 6297, from Cumberland Gulf, April, 1878, collected by L. Kumlien. As representing the Otariidae, the National Museum secured through the interest of the Johns Hopkins Medical School an embalmed juvenal female *Zalophus californianus* that died September 6, 1925, after being at the Baltimore Zoological Park for only a short time. Sundry anatomical observations were also made upon a large adult female of this species that died at the National Zoological Park during June, 1927. For osteological comparison the most suitable skeleton available was that of a subadult male, disarticulated, No. 200847 of the National collection, that died at the National Zoological Park December 19, 1915. There was also at hand some less satisfactory skeletal material of this same species, some of *Phoca*, mounted skeletons of both families, and an extensive collection of skulls. It should be understood that in the following pages the above specimens, upon which the present study is primarily based, are referred to not by number, but by such terms of designation as "the otariid" (the embalmed specimen for the muscles, and the skeleton for osteological details), or "my phocid." My study of the prepared specimens has been supplemented by observation, as often as possible, of both wild and captive specimens of *Zalophus* and *Phoca* (of the *vitulina* and *richardii* sorts).

EXTERNAL FEATURES

The length from nose to tip of tail was 978 in the *Zalophus* and 1,019 mm. in the *Phoca*, so these embalmed specimens were as nearly comparable in size as one could reasonably wish. The length of tail in the former was 60, and in the latter 72 mm., and the circumference of the thorax respectively 430 and 780 mm. The sea lion was excessively emaciated and not only was there no fat but most of the muscles where somewhat shrunken. The seal, on the contrary, was very fat, this being tender and free from fibrous tissue. Over the shoulder it was about 30 mm. in thickness, thinning toward the head, caudad in the region of the hind flippers, and upon the forelimbs. In a state of nature females and immature males of *Zalophus* are usually sleek and of slender appearance, although captive specimens and old males may become fat and logy; but it is normal for at least most of the Phocidae to have an extensive blubber layer. All pinnipeds have a form that is markedly "stream-line" but which animal is the more efficient in this respect we do not know. Both are covered with short stiff hairs, the pelage of the phocid being the thicker.

In the otariid the mystacial pad had a width of 40 mm. and appeared rather narrow. The vibrissae were directed chiefly caudad

and the nostrils were directed at an angle of about 15° or possibly 20° rostro-dorsad of the cranial axis. The mystacial pad of the *Phoca* had a width of 75 mm. and appeared very wide and as though inflated. The vibrissae were directed mostly laterad, but also downward and forward, and the whole mystacial area was more walrus-like than that of the otariid. The nostrils were directed rostro-dorsad at an angle of about 45° to the cranial axis, thus being situated more dorsad than in the sea lion. The direction of the eyes in the otariid was at an angle of about 50° with the vertical, and about 15° in the phocid. The eye was larger in the former, the width between the canthi being 70 mm., and in the phocid 40 mm. The latter had a few supraorbital vibrissae, which were entirely lacking in the former. In the *Zalophus* the pinna of the ear is slender and with a length of 28 mm., while the *Phoca* has no pinna. In both animals the auditory tube is of considerable length, but because of the more arched cranium of the otariid, especially in old males, the auditai orifice is located relatively less dorsad than in the phocid. Thus, in the latter the nostrils, eyes, and ears occupy a position more decidedly dorsad.

The neck of a small otariid is very mobile, and as it is relatively slender, it appears longer than the very broad neck of a phocid, tapering, as it does, to the head. In the eared seals the necks of bulls develop to an astonishing extent, however, this being partly muscular for combat and partly fatty. In this family the base of the neck and thorax are cylindrical, or even slightly flattened transversely in form, while in *Phoca* the tendency has been farther away from the typical terrestrial carnivore and there is an appearance of slight flattening dorso-ventrad. The whole body appears definitely longer in the sea lion, but this is difficult of proof. In this animal the lumbar region is exceedingly limber, because of the elasticity of the intervertebral disks and the form of the vertebrae themselves, this being so largely as an aid to terrestrial locomotion; but such is not the case in the earless seals, in which there is apparently no marked ability to bend the lumbar region ventrad. In the otariid the tail was virtually conical with a length of 60 mm., but in the phocid this member, 72 mm. long, was flattened dorso-ventrad, measuring 43 mm. in width by 25 mm., and fit nicely into the angle formed by the adpressed hind flippers.

In the otariid the axilla[1] was at a point a trifle proximad of the center of the ulna, but in the *Phoca* it was opposite the ulnare. In the former the visible portion of the fore leg had a length of 300 mm. from the axilla and was very highly modified as a paddle, being

[1] The term axilla as herein used is employed to designate the ventral and caudal juncture of the fore limb with the body, not in its more precise meaning of the region beneath the shoulder joint.

thicker and longer upon the cranial border and thinner and shorter upon the caudal one. Each digit had a minute circular nail set within a pit in the integument, located approximately at the end of the terminal phalanx, and a cartilagenous prolongation of the digits extending considerably farther. The distance from the metatarso-phalangeal joint of the first digit to the nail was 85 mm., and from the nail to the termination of the digit, 65 mm. The entire manus was rather stiff, without free movement of the digits, and there was a minimum of possible abduction or adduction. The interdigital membrane reached to the ends of the digits, and the sole was naked and wrinkled. In the *Phoca* the external part of the foreleg measured but 100 mm. from the axilla and was not highly modified into a paddle. The manus was short and broad and hairy upon the palm, it was abducted more than in most mammals, and the articulations of the carpal bones were loose to the touch. As in the otariid the first digit was the longest, and there was sequential diminution to the fifth, but in that animal the difference in length between these two was very marked and in the phocid very slight. There are broad, heavy nails upon all the digits of the latter, and there are no cartilagenous extensions.

The crotch, between the hind limb and tail, was in the otariid at the most caudal of the muscles between the innominate and the leg, but in the *Phoca* conditions differed, for there was a considerable distance between the crotch and the last muscles, this being occupied by tough fatty tissue. In the former animal the crotch was opposite the middle of the calcaneal tip (heel), while in the phocid it was located about 20 mm. farther caudad, a distance not sufficient to make much difference in the mobility of these members. As discussed more fully elsewhere the hind foot of the otariid readily assumes a plantigrade position at an angle of 90° with the shank, while in the *Phoca* the angle so formed, without undue forcing, does not exceed 60°. From the crotch the hind limb of the latter measured 220 mm. in length, and of the otariid, 260. When viewed from the rear with joints as relaxed as it was possible to get them in the preserved specimens the plantar planes of the feet of the otariid presented the appearance of a very steep-sided V, and in the *Phoca*, of an equally steep-sided Λ. Pronation and supination corresponded with these positions, but so little of the leg projected from the body that one could not determine the precise amounts. In both animals the first and fifth digits are considerably the most robust and the longest. In the *Zalophus* only there is also a cartilagenous extension to each digit. The distance from the metatarso-phalangeal joint to the nail of the first digit measured 77, and from the nail to the tip of the toe, 78 mm. The cartilages of the middle three digits were relatively a bit shorter, and that of each toe projected beyond the interdigital membrane, as shown

in Figure 24. The extended breadth of the hind foot at the nails was 133 mm., but the difference between the collapsed and extended width was slight. Upon the first and fifth digits there were little more than nail pits, as in the case of the fore foot, but the nails of the middle digits were long, slender, and almost straight. Unlike the case of the fore foot, the digits of the pes in this genus are capable of considerable flexure, even to the cartilages, and the latter may be flexed out of the way of the nails, permitting the use of these in scratching. The sole is naked, but is covered with hair in the phocid. In the latter the first and fifth toes are relatively more robust than in the otariid and possible abduction of these digits is much greater, partly because of the more generous width of the interdigital membrane. Thus the greatest width of the foot at the base of the nails was 190 mm. in this specimen. Whereas in the otariid the static posture assumed by the hind feet in the water is usually somewhat trailing and relaxed, in the phocid they are usually adpressed and, especially on land, carried straight out behind and unsupported. All five digits have exceedingly slender, almost straight nails.

OSTEOLOGY

It is intended here to present not a complete description of the skeleton of two species of pinnipeds as such, but rather to compare critically two skeletons which are considered to be representative of the families Otariidae and Phocidae. Minor differences in the interrelationship of the bones of the skull are not dwelt upon, but rather is it intended to enumerate and attempt to evaluate those differences which are belived to be functional, as well as the phylogenetic ones, to discover why and to what degree pinnipeds differ from fissipeds, and in just what manner otariids differ from phocids. The osteology of the pinnipeds has been described by a number of others but no one heretofore has investigated the mechanical and myological reasons for their osetological details.

It has been impossible in the present instance to accumulate skeletons of all, or even satisfactory material representing the majority of, pinnipeds, but comparisons of skulls have been made, family characters as based upon cranial details have been checked over, and where the characters of the otariid or phocid differ from those common to their respective families, these are mentioned.

Other than of juveniles but one skeleton of *Phoca hispida* (No. 6297, Mus. Comp. Zoöl., Cumberland Gulf, April, 1878, sex unrecorded, by L. Kumlein) could be located, and this is compared with one of a subadult male *Zalopus californianus* (No. 200847, U.S.N.M., from National Zoological Park, December 19, 1915) which is nearer the same age than any other at hand. For comparison certain meas-

urements and percentages are also presented of the skeleton of an adult cat (*Felis catus*).

Some vertebral measurement was needed as a standard of comparison but it was thought advisable to exclude from this the cervical series. The sum of the length of the thoracic, lumbar and sacral vertebrae has therefore been taken as a yardstick. It was found that this measurement in the *Phoca* skeleton was almost precisely seven-tenths that of the *Zalophus*. In drawings of single bones of the latter the scale is, therefore, as though the osteological details of this individual were precisely seven-tenths of their true size. Attention should be called to the fact that classification of the osteological characters as being of myological or phylogenetic derivation is at times arbitrary and purely for convenience. Any character doubtless become phylogenetic if present for a sufficient length of time. By "transverse process" is meant any vertebral process situated laterad without reference to its homology, as of the atlas or of a sacral vertebra.

SKULL

The illustrations give a better idea of the general form of the skull than can a description. That of the *Zalophus* is long and narrow, and in the *Phoca* short and broad, most of the difference in length occurring anteriorly. In the *Zalophus* the skull is 27 and in the *Phoca* 23 per cent of the body length. In the same order the glenoid-rostral measurement is respectively 70 and 61 per cent of the total length of the skull, and that for breadth to length is 53 and 66 per cent respectively. Beginning rostrad it is seen that there has been a slightly greater recession caudad of the anterior nares, relative to total length of skull, in the *Phoca*. In the *Zalophus* there is a well defined process formed by the premaxillary tips, which is absent in the *Phoca*. The reason for this is apparently either muscular or possibly cartilagenous, but nothing to account for it was met during dissection. Similarly the anteorbital processes of the maxillae, present in *Zalophus* only, should be due chiefly to details of the orbicularis oculi, and possibly also the frontalis, but as mentioned later I am not reporting upon the facial musculature. The absence of supraorbital processes in the *Phoca* and their presence in *Zalophus* is correlated first with the lack in the former of a distinct "interorbital" extension of the temporalis, with the greater size in that animal of the eyes and the true orbits (as distinguished from the anterior temporal fossae), and their more dorsal position, or rather, the more pronounced ability of the eye to look straight up. This more dorsal direction of sight can be accomplished in two ways—(*a*) by a bowing out and broadening of the zygomatic arches, accompanying which change there must be either a decided increase in the strength of the

masseter muscles or a corresponding increase in the breadth of the lower jaw, accompanied by certain rather complicated changes, both muscular and osseous, in the region of the palate; or (*b*) by a decrease in width of the interorbital septum, to this extent allowing the eyes to roll upward and inward. The interrorbital septum of all pinni-

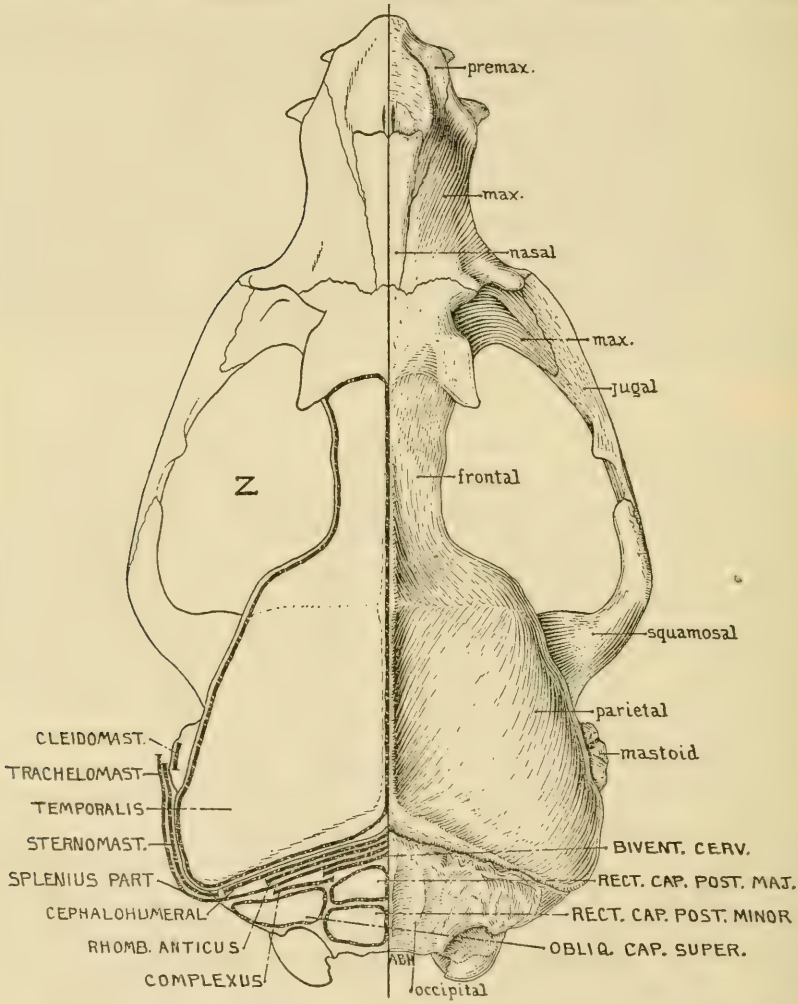


FIG. 2.—DORSAL VIEW OF THE SKULL OF ZALOPHUS SHOWING AREAS OF MUSCLE ATTACHMENTS LABELED IN CAPITAL LETTERS; NAMES OF BONES IN SMALL TYPE

peds is proportionately thinner than in existing terrestrial carnivores, indicating that even in the *Zalophus* in which interorbital breadth is 11 per cent of total skull length, dorsal vision is used considerably. In the *Phoca*, however, this is excessively thin, its width dorsad being but 3 per cent of the length of the skull, and more

ventrad almost paper thin, allowing the animal to look straight up with ease. In some of the Phocidae (as *Stenorhynchus*) the interorbital septum is not more reduced than in the sea lion, the skull is long and narrow and the orbit is not especially large. In the *Phoca hispida*, as previously mentioned, the zygomatic width is relatively great and the orbit proper, large. The size of the eye has resulted

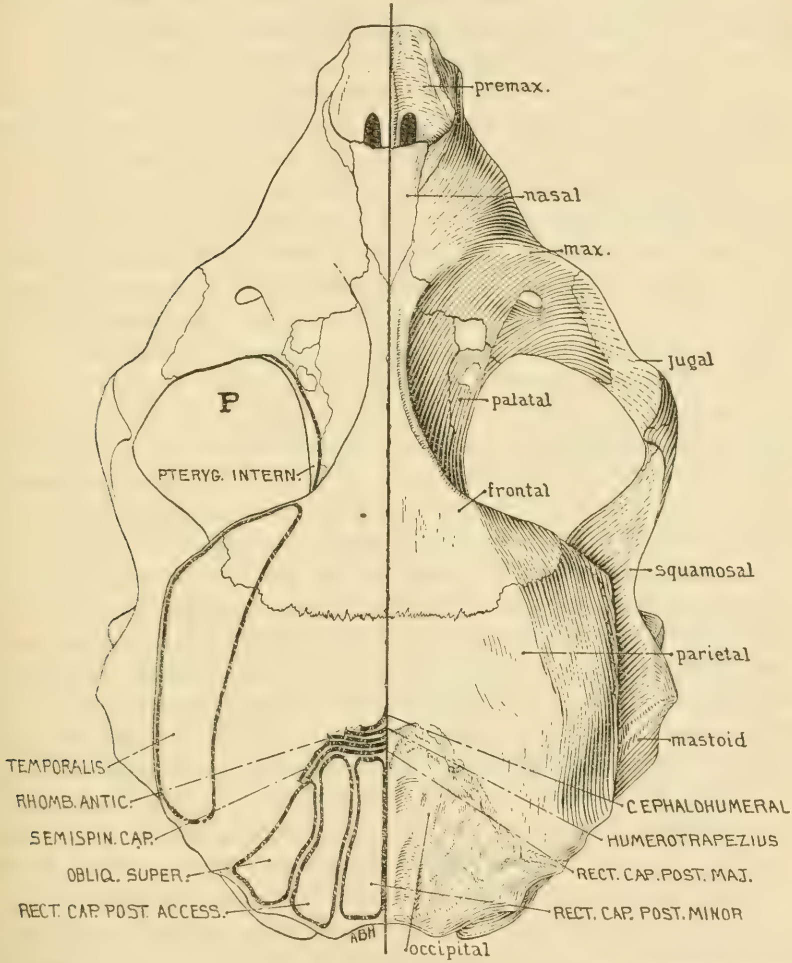


Fig. 3.—Dorsal view of the skull of Phoca hispida, showing areas of muscle attachments and (in small type) names of bones

in the forcing caudad of the postorbital process of the zygoma to a point immediately caudad of the malar-squamosal suture, while in *Zalophus* (and some phocids, as *Stenorhynchus*) this process is located considerably craniad of this suture.

Within the orbit it is seen that the excessive thinness of the interorbital septum of *Phoca hispida* has crowded the ethmoturbinals to

such a degree that these have actually forced their way here and there through the fragile frontals which overlie them. An occasional *Zalophus* skull has what appears to be an imperforate lachrymal between the maxilla and frontal just within the orbit. In the search for this bone in the Phocidae one needs be careful to identify the maxilloturbinal, a smooth part of which is often to be seen on the border of the orbital vacuity. Certainly the bone is entirely absent in the vast majority of phocids, having either dwindled and disappeared from the maxillo-frontal suture, or what seems more logical, has been forced by the enlargement of the orbit relatively farther caudad, and now represented perhaps by cartilage within the confines of the maxillo-frontal vacuity, which cartilage would disappear during cleaning of the skull. In *Stenorhynchus* only among phocids have I been able to find a bone which might represent the lachrymal and the homology of this is uncertain. In a single skull of this genus there is a small bone bounded by the vacuity, maxilla and palatal which may be the lachrymal. The maxillo-frontal vacuities of the orbit are usually much larger in the otariids than phocids, although the smallest in the former may be no larger than the greatest in the latter. The infraorbital foramen is relatively larger in the *Zalophus* than in *P. hispida*, but there is much variation in this item within the two families. Its size in the pinnipeds is an index to the development of the infraorbital nerve, which serves the mystacial pad. The maxillo-naso-labialis muscle, which is the chief mechanism for opening the anterior nares, arises from the maxilla directly caudo-ventrad of the infraorbital foramen. The point of origin is not indicated upon the skull of *Zalophus* nor of most phocids, but it is marked by a relatively deep fossa in *P. hispida*. The only noteworthy feature of the zygoma that has not been mentioned is the apparent fact that in the Otariidae the malar extends to the glenoid fossa, which it does not quite do in the Phocidae. One not infrequently encounters the statement that in the Otariidae the dorsal process of the zygomatic arch occurs definitely craniad of the jugal-squamosal suture, while in the Phocidae it occurs either at this point or a bit caudad. This is a secondary character and the position of the process is attributable to the relative size of the orbit, and hence, of the eye. As usual the zygoma tells little in regard to the masseter muscles.

The molars of the Otariidae are simple and conical, evidently having assumed their present form because of the slight use to which they are put in simply helping to tear fish and similar food, rather than in shearing tough meat and gnawing bone, as is the habit of the fissiped. The molars of the Phocidae are of a more complicated form and have at least two cusps—often more. Presumably the food predilections of all pinnipeds are very much the same, and it is not

only impossible to explain the dental differences between the two families at the present time but in the absence of ancestral remains it is unsafe to theorize on the probable development of the tooth patterns. The dental arch is different in the two families, being narrow in the *Zalophus*, with alveoli almost parallel, while these diverge to a greater extent in phocids, with *Stenorhynchus* occupying an intermediate position in this as in so many other respects. The palatal region is narrow in *Zalophus* and broad in the *Phoca*, while the hamular processes are located far caudad in the former of their position in the latter animal.

In classifications of the Pinnipedia attention is usually called to the presence in otariids and the absence in phocids of the alisphenoid canal, mediad of the glenoid fossa, for the passage of the external carotid artery. This is a convenient character for classification but is not necessarily a precise criterion, for in the skull of a fur seal (*Callorhinus alascanus*, No. 237266 U.S.N.M.) this canal is present upon the left side but absent on the right. In *Zalophus* the foramen rotundum (for the maxillary nerve) is just craniad of this canal, and in the *Phoca*, mediad to the anterior part of the glenoid fossa. Next caudad is the foramen ovale (for the mandibular nerve), and near this, the Eustachian canal. The apparent position of the stylomastoid foramen (for the facial nerve) differs in the two animals, but in both it is located as usual between the audital bulla and the mastoid. Ventrad of the basioccipital level upon the medial side of the bulla in the *Phoca* is the carotid canal (for the external carotid artery) and the direction of this is latero-dorsad. In the *Zalophus* this foramen is mostly dorsad of the lateral margin of the basioccipital, and its direction is directly craniad. A probe introduced from the caudal end emerges into sight next to the Eustachian canal. The jugular, or posterior lacerated foramen is next caudad, this being a large fenestration in both, but somewhat more extensive in the *Phoca*. Between this and the condyle is the condyloid foramen (for the hypoglossal nerve), larger in the *Zalophus*, but this difference is not found to be uniform in the other pinnipeds.

The pterygoid fossa is much broader in *Phoca hispida* than in *Zalophus* but the significance of this is not readily interpreted. The irregularity of the surface of the basioccipital in the latter indicates stronger anterior rectus capitis muscles in this animal. In this as in certain other species of phocids (as *Cystophora*) there is a large medial vacuity in the basioccipital, which seems never to occur in otariids. In all eared seals apparently the occipital condyles are relatively narrow, while in the Phocidae they are much more flaring, this being especially pronounced in *Phoca hispida*. The reason for this is evidently that the articulation of the head with the neck has

greater need for mobility in otariids, which is accomplished partly by a reduction in the width of the joint.

The paroccipital processes vary greatly in the degree of their distinctness in pinnipeds. In otariids they are apparently always well defined and continuous, by a crest, with the mastoid processes.

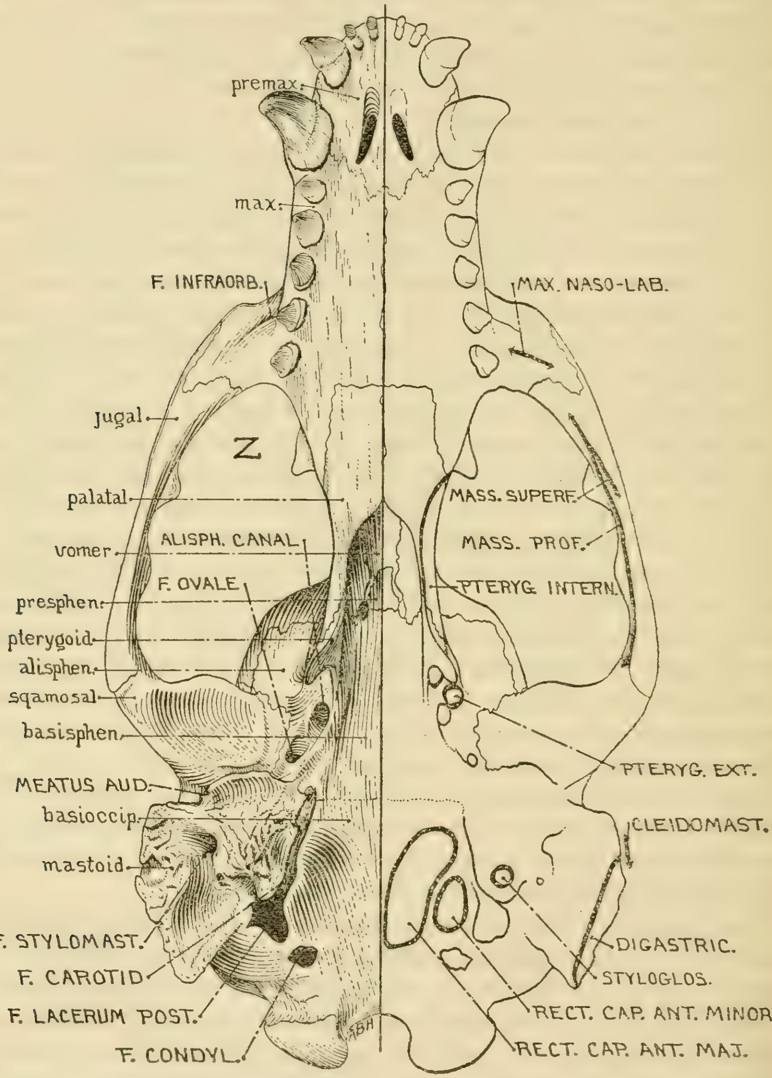


FIG. 4.—VENTRAL VIEW OF THE SKULL OF ZALOPHUS; NAMES OF BONES IN SMALL TYPE

In those phocids in which they are distinct they are never continuous with the latter, but they may be either sharp and projecting (*Monachus*, *Stenorhynchus*), or absent as true processes (*Mirounga*), their position being indicated merely by slight swellings in that part

of the bone. The latter description fits the condition in *Phoca hispida*. In the *Zalophus* the paroccipital-mastoid process begins at the posterior lacerated foramen and extends caudo-laterad. The crest then turns and extends craniad, broadening abruptly and ending as the caudal boundary of the external auditory meatus. Even in the subadult skull there is no indication whatever of a distinct mastoid, it having to all intents disappeared in the parietal-occipital

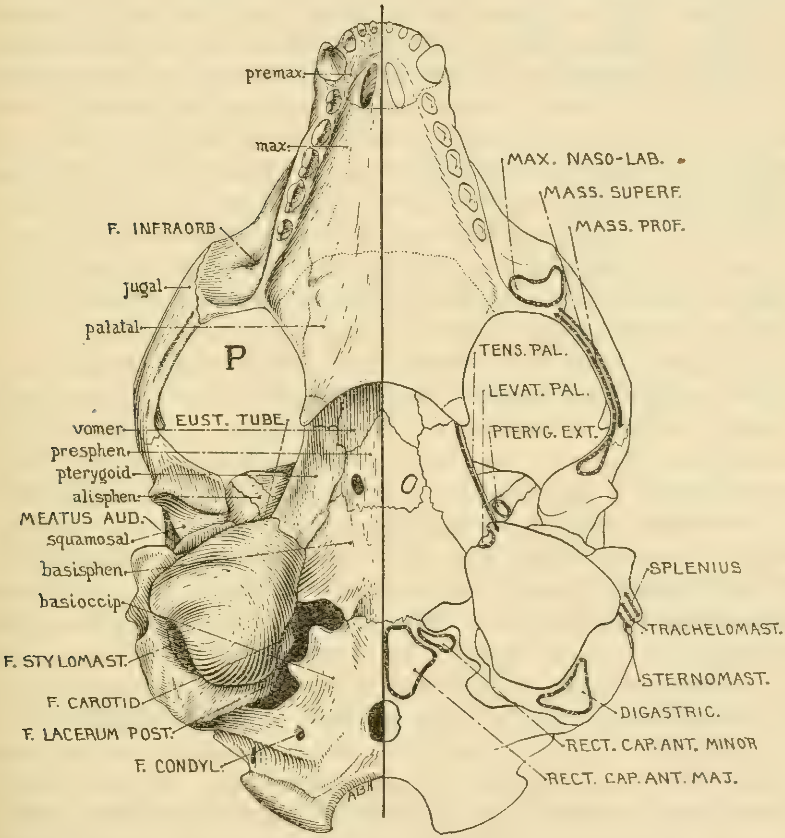


FIG. 5.—VENTRAL VIEW OF THE SKULL OF PHOCA HISPIDA; NAMES OF BONES IN SMALL TYPE

fusion. In *Phoca hispida* there is the slight swelling denoting the position of the paroccipital process, and from this, a lateral bulge of the somewhat inflated mastoid, nonmuscular in character, to the moderately developed mastoid process located caudad of the bony lip of the auditory meatus. As previously inferred, in those phocids which have prominent paroccipital processes there is no continuous prominence from this to the mastoid process. In a fetal *Phoca vitu-*

lina the paroccipital process is much better developed than even a postnatal individual of *Callorhinus*.

If the paroccipital-mastoid crest of the *Zalophus* be viewed as an extension ventrad of the bone, there is little muscular stimulus to be seen—nothing save that of the digastric. If it be viewed as chiefly a lateral development, then there is more reason. In *Phoca hispida* none of the long muscles is attached to the lateral part of the occipital crest, the three muscles of the mastoid process are narrowly tendinous, and the digastric arises from a pit between the mastoid and bulla. This accounts at least partially for the suppression of the paroccipital process as such in the *Phoca*—for there are no muscles attached thereto—and for the moderate size of the mastoid process, with its three muscles. In *Zalophus*, however, the powerful cephalohumeral, the splenius-trachelomastoid insertion, and the sternomastoid—which always has a significant effect upon its insertion—are attached to the latero-ventral part of the occipital crest, and in addition, the digastric arises all along the paroccipital-mastoid crest. There is no attachment at all confined to the mastoid process in its restricted sense save the weak cleidomastoid.

The audital bulla in otariids is small, shrunken-looking and often rugose, extending to form a projecting lip to the auditory meatus directly ventrad of its orifice. There are certain phocids with an intermediate type of bullae, as through *Monachus* to *Stenorhynchus* and then *Phoca*, the culmination being in *Cystophora* with its great globose bullae: and in phocids the projecting lip of the meatus is situated more caudad. A fundamental difference in the bullae of the two families is to be seen in the fetal state. In a *Callorhinus* skull (length 96 mm.) the bullae are very small, noninflated, with tympanic ring very distinct, and border of the auditory meatus regular and subcircular. In one of *Phoca vitulina* (length 113 mm.) the bullae are perhaps 10 times as large, roundly inflated and with the ecto-entotympanic suture almost obliterated, the two parts combining to form a single evenly rounded surface. A point of great phylogenetic importance is the fact that the border of the meatus is irregular and the bone deeply indented cranioventrad, indicating a phylogenetic difference in the procedure of ossification at this point. This same character, but to a slightly different degree, is seen in very young bears (*Ursus*) although in these there is no apparent ecto-entotympanic differentiation, but it even more resembles that found in puppies (*Canis*). A far different condition obtains in the otter (*Lutra*) or any mustelid which I have examined.

In the fetal *Callorhinus* the mastoid exhibits slight inflation, but this rapidly disappears soon after birth and the bone is apparently solid, and thin save where it projects toward the paroccipital-mastoid crest. A very different condition obtains in *Phoca* (*vitulina*), how-

ever, for in a large fetus the mastoid is almost as much inflated as the audital bulla, and the proportions are found to be much the same as in the adult. This character of inflated mastoid is common, in varying degree, to all the Phocidae. As the functions, if any, of mastoids of different degrees of inflation have never been discovered, it is useless to speculate on the differences encountered in the pinnipeds.

In the fetal *Phoca* skull there is a pair of symmetrical bones, one on either side, bounded by the mastoid, parietal, supraoccipital and exoccipital, and measuring 21 by 10 mm. These are found in those few very young *Phoca vitulina* skulls that are available, but their outlines become obliterated in older animals—even in immatures of medium size. In an adult skull of *Phoca groenlandica*, however, and a subadult of *Cystophora*, these accessory bones can be perfectly traced. They can not be considered as Wormian bones, for they are too symmetrical and too regularly situated. It seems justifiable to consider them as a phylogenetic remnant, comparable to the "reptilian" supernumerary bones of some insectivores. (See Wortman, 1921.) I can not, however, find that their undoubted homologue exists in the skull of any reptile which I have encountered in the literature of the subject, unless they are comparable to supratemporals of such a genus as *Procolophon;* and I am far from convinced that this is likely.

In all adult otariids the temporal muscles reach the sagittal crest and in old males they attain a phenomenal size, as indicated by the development of the crests—in fact far larger than one imagines would be of practical use to an animal with such dentition and with such a diet. In a sagittal direction these fossae extend from the lambdoidal crest to the supraorbital processes. In many phocids (as *Mirounga* and some *Phoca*) these muscles also reach the sagittal crest, but as a rule they are much weaker in this family and do not encroach so far onto the frontals. It may be that no old male of *Phoca hispida* is available, but I have seen none in which these muscles reach the sagittal line. In the skull upon which this osteological study is chiefly based they are far apart and weak.

In fetal skulls the supraoccipital of *Phoca* has a more definite rostral inclination than in *Zalophus*. In adults of the latter genus as well as in some phocids (as *Cystophora*) the supraoccipital plane slopes gradually, but in all phocids the occipital crest exhibits quite a sharp angle in the middle portion of either half. This assumes almost a right angle in the *Phoca hispida*, in contrast to the more even curve of this crest in *Zalophus*. The reason for this is not hard to find, for in the otariid the different muscles of paroccipital-supraoccipital insertion are more or less evenly distributed for the entire

length of the crest, while in *Phoca hispida* they are segregated in the regions of the mastoid process and the medial part of the occipital crest. And the latter is therefore the part that has been pushed rostrad in response to certain muscular stimuli, as will be discussed elsewhere. The part of the skull anterior to the supraoccipital has resisted in varying degree the rostral push of the latter bone, the force of resistance being supplied by the density of the water through which the pinniped moves during locomotion. The result, where marked, may be compared to the first stages of the "telescoping" of certain of the cranial elements, as exemplified to

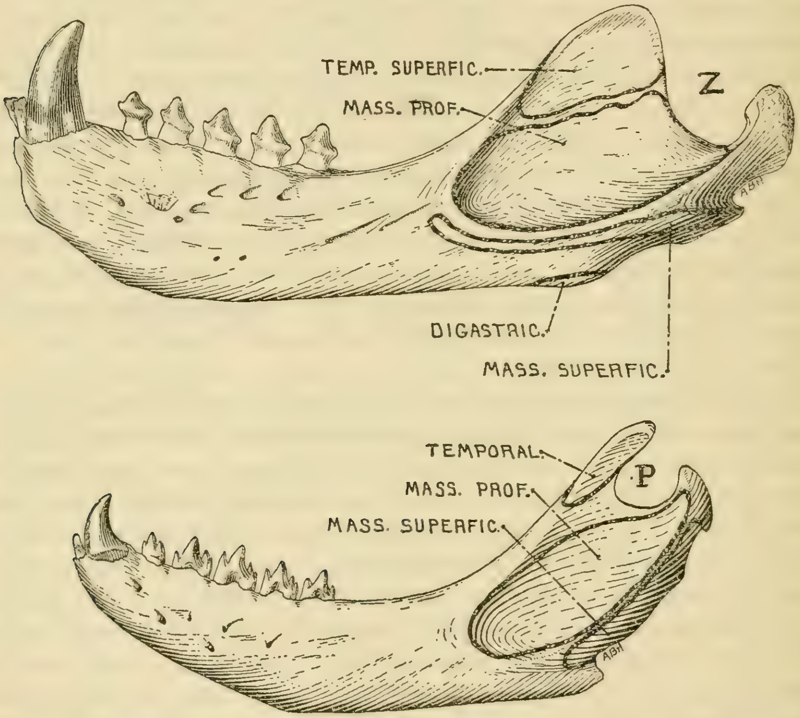


FIG. 6.—LATERAL VIEW OF THE LEFT MANDIBLE OF ZALOPHUS (*Z*) AND OF PHOCA HISPIDA (*P*), SHOWING AREAS OF MUSCLE ATTACHMENTS

such a remarkable degree by the cetacean skull. An indeterminate, though probably small, number of fissiped Carnivora exhibit to some slight extent a sliding movement of the occipital plane, a prerequisite being a squamous, rather than a dentate, type of suture between the bones involved, and some mechanical stimulus is undoubtedly also a necessity. Thus in the skull of an immature *Arctonyx leucolaemus obscurus* (which is supposed to use its nose in digging) with a length of 123 mm. the supraoccipital overlaps the parietals by as much as 8 mm. In the immature skull of an otter (*Aonyx*

cinerea) of 82 mm. the overthrust amounts to 5 mm. A juvenal skull of a *Callorhinus alascanus* of 134 mm. exhibits this condition to an extent as great as 25 mm. It was therefore surprising to encounter in a large immature of *Phoca vitulina* with a skull length of 145 mm. an overthrust amounting to but 8 mm., and this only for 10 mm. upon either side of the sagittal line, laterad to that point it being but a couple of millimeters. Both the otariid and the phocid presumably have encountered, during their aquatic existence, the same or a very similar sort of mechanical stimulus exerted by the water upon the head. It is therefore necessary that the great difference in the amount of this osteological overthrust exhibited by the supraoccipital be accorded phylogenetic significance of great weight.

The form of the mandible is chiefly influenced by that of the skull proper. To conform to the heavier dentition and musculature of *Zalophus*, its mandible is stouter than that of *Phoca hispida.* The coronoid process is very much broader and more suited to the insertion of a large temporal muscle, but relatively the masseteric fossa is about the same in both. The insertion of the superficial part of the masseter is horizontal in *Zalophus* and at an angle of about 45° in the *Phoca*, which variation is at least partly mechanical and due to the fact that in the former the mandible is almost straight, while in the latter it is much curved. This condition has been brought about by the position in the *Phoca* of the glenoid fossa, situated well dorsad of the maxillary tooth row, causing a corresponding position of the mandibular condyle well dorsad of the mandibular tooth row. There is much specific and generic variation exhibited by the mandibles of the two families, however.

HYOID

There is available no adult pinniped skeleton in which the hyoid complex is entirely satisfactory. It is, however, of the usual carnivore type, with basihyal, lesser cornua consisting of short thyrohyal (no chondrohyal was noted), and greater cornua. The latter comprise ceratohyals, adjoining the basihyal, and then in sequence epihyals, stylohyals, and tympanohyal elements, although it is not certain if the latter are completely ossified in all pinnipeds.

VERTEBRAL COLUMN

As previously mentioned, the sum of the thoracic, lumbar, and sacral series of vertebrae is used as a standard with which to compare each series. Unfortunately, no account can be taken in the cleaned skeleton of the thickness of the intervertebral disks; but after all, what is desired is just *some* standard for comparison. The column

of *Zalophus* comprises 44 vertebrae and of the *Phoca* 45,[2] which seems to be a greater number than is possessed by most pinnipeds because of the numerous caudals. It is, of course, almost impossible to decide whether there has been any actual lengthening of the pinniped vertebral column in relation to general body mass. There seems to be a tendency toward lengthening of the thorax in the Otariidae at least, but the lumbar length of fissipeds is entirely too variable for one to make comparisons in this series. Outstanding details of the vertebral column are the slight development of the spinal processes in phocids, highest in the extreme anterior thoracic series of otariids; the thickness and evidently great elasticity of the intervertebral disks, especially in the cervical and lumbar region of otariids; and the osteological provision, also especially in the otariids, to allow for extreme mobility of the individual vertebrae, the pre- and post-zygapophyses being reduced and also all bony details that might collide with an adjoining vertebra during contortive movements. The nomenclature used for the vertebral processes is that most often employed (see Howell, 1926), save in the case of the diapophyses. It is perhaps wise to employ this term only for such inferior processes when they arise from the neural arches, terming them parapophyses when they arise from the centra. I do not pass upon the propriety of this course but follow it for the reason that it conforms to embryological evidence. The investigation of the variation in the back musculature from a comparative standpoint is one that takes a high order of specialization on the part of the investigator, and until some qualified person shall have done this the homolgy of the vertebral processes must be considered as not unassailably established.

Cervical vertebrae.—The cervical series numbers seven as usual. In the *Zalophus* it measures 24 and in the *Phoca* 26 per cent of the body length (27 in a cat). That this difference is so slight is rather surprising, for with its apparently longer body, the otariid appears to have a much longer neck; but the difference is increased during life by the considerably greater thickness in the former of the intervertebral disks. Although the cranial articular facets in *Zalophus* are relatively much narrower than in the *Phoca*, to allow for greater freedom of movement in the former, the transverse processes are somewhat broader and directed more ventrad, a condition attributable in part to the greater complexity in this otariid of the longus colli. To this stimulus is also partly due the differences shown by the more ventral of the vertebral processes. The axis in both animals has a very small process which seems to be an anapophysis. In the *Zalophus* the third cervical shows ventrad only the parapophysial

[2] See p. 22.

plate, with the suggestion of two processes upon its caudal and one upon the cranial termination. In the fourth the cranial has disappeared, or rather is undifferentiated from the remainder of the plate, but the two caudad are more distinct, the superior being directed farther dorsad. In the fifth this has become a distinct anapophysis, separate from the papapophysial plate. In the sixth this condition is much more pronounced and the robust caudal termination of the parapophysial plate exhibits a separate center of ossification. In the seventh, partly because this is the first vertebra lacking a lateral vertebral canal, the inferior process, which is a true process and not a plate as in those more craniad, is situated more dorsad, where it should be considered as a diapophysis. It also has an anapophysis like the sixth. Metapophyses are lacking in all. Conditions are somewhat similar in the *Phoca* with the exception that there is little tendency for the parapophyses to be platelike, save the sixth as usual and in the seventh the anapophysis and diapophysis have virtually fused. In the *Zalophus* there is a gradual increase in the height of the neural spines from the third to the seventh, the latter being 53 mm. in height above the neural canal, while in the *Phoca* there are really no spines upon the last five cervicals, that of the seventh measuring but 12 mm. in height.

THORACIC VERTEBRAE.—The thoracic series of vertebrae normally constitutes 15 in all pinnipeds except *Odobenus*, in which there are 14, for out of 47 individuals of 14 species and genera, of both orders, Thomson (1909) encountered but 1 with 14 thoracics; so Flower (1876) was mistaken in his statement that *Phoca* has but 14. In *Zalophus* the series constitutes 67 per cent, and in the *Phoca* 57 per cent of the body length (46 in a cat). Hypapophyses are distinctly present in the first four and the fifteenth, the latter especially pronounced in the otariid. The neural spines gradually decrease in caudal sequence from the first, which is of about the same height as in the seventh cervical, and they exhibit no pronounced anticline or change in direction, as they do in most carnivores, nor any abrupt change in character, although there is a gradual broadening of the spines. As far caudad as the eleventh vertebra in *Zalophus* the articular surfaces of the zygapophyses are horizontal. Those between the eleventh and twelfth and thereafter (including the lumbars) become progressively more vertical, but the significant feature in this animal is that in all posterior to the first few the two postzygapophyses of each vertebra are exceedingly close together, theoretically allowing of great freedom of movement. In the posterior thorax, however, there is such interlocking of the zygapophyses that a very concave outline of the dorsum can not be assumed, but the convexity, especially in the lumbar region, is only limited in degree by the elasticity of the intervertebral disks.

In the *Phoca* the spines, especially caudad, are but little more pronounced than the other processes. The change in the direction of the articular surfaces of the zygapophyses between the eleventh and twelfth thoracics as mentioned for *Zalophus* is much more abrupt and especially caudad and in the lumbar region the zygapophyses of each vertebra are situated much farther apart—relative to size, over three times farther. The interlocking is such as not to prevent as marked concavity in the outline of the dorsum as the limitations of the sternum will permit, but it is impossible in the cleaned skeleton to judge of the amount of convexity that is possible. This seems to be not so great in the case of the phocids, however.

The transverse processes of the first 11 thoracics in *Zalophus* consist merely of blunt protuberances above the costal facets. They embody, however, met-, an-, and possibly diapophyseal elements, which begin to separate in the twelfth. Metapophyses are of increasing distinctness in the thirteenth, fourteenth, and fifteenth, but anapophyses are absent upon the fifteenth thoracic. There are certainly no diapophyses to the posterior thoracic vertebrae of *Phoca* and a small but sharp anapophysis is present upon the fifteenth; otherwise the lateral details of the two genera are very similar. The first 10 ribs of *Phoca* have both capitular and tubercular attachment to the vertebrae, and of the remaining 5, capitular only. Because of the poorer definition of the facets in the *Zalophus* skeleton (disarticulated) these details could not be determined with certainty, but because of vertebral similarity I judge that the costal conditions are the same.

Lumbar vertebrae.—Unfortunately the *Zalophus* skeleton had but four lumbar vertebrae and the one of *Phoca hispida* three. Thompson (1909) ascribes to Barrett Hamilton a statement that "in most seals the numbers of thoracic and lumbar vertebrae appear to be usually 15 and 3, more rarely 14 and 6." The above figure 3 is probably a misprint for 5, and with this exception I can find no published statement of any otariid or phocid with less than five in this series, while the number appears always to be six in *Odobenus*. It therefore seems justifiable to assume that one lumbar vertebra from the *Zalophus* and two from the *Phoca* have been lost and to compute the lumbar length on the basis of five vertebrae. In *Zalophus* this computed item was 22 and in the *Phoca* 26 per cent of the body length (46 in a cat), and yet in proportion to general body mass the lumbar series seems relatively the longer in *Zalophus*. On the whole these vertebrae are of the same character as the more caudal of the thoracic series save that there are no vestiges of anapophyses and the inferior processes consist of broad parapophyses, relatively much better developed in the phocid. In conformity with the previously mentioned fact that in the latter the zygapophyses are much farther

apart transversely, the metapophyses are also farther apart. In both there are hypapophyseal keels to all the lumbars.

As previously mentioned the outstanding character of the vertebral column as a whole is the looseness of the articulations. The cat is looked upon as being rather a limber mammal, but its vertebrae are far more securely interlocked than are those of the pinnipeds.

Sacral vertebrae.—The sacral series in the pinnipeds is almost always three, although Flower and Lydekker (1891) say four. In all of the 47 individuals of divers sorts examined by Thomson (1909) there were three, as there is in my *Zalophus* skeleton, but in the *Phoca hispida*, a *Phoca groenlandica* in the National collection, and apparently always in *Odobenus*, they number four. In *Zalophus* they constitute 11 and in the *Phoca* 14 per cent of the body length (8 in a cat), but this detail is of but slight value because of the difference in the two in the number of the sacrals. In the *Phoca* but not the *Zalophus* the postzygapophyses of the last lumbar and prezygapophyses of the first sacral are so shaped as to allow the whole sacrum, and thus the pelvis, to be elevated above the general vertebral axis, bowing the back concavely at this point. The specimens available had the articulation of the pelvis with the sacrum confined to the first sacral except in *Odobenus*, in which the first three sacrals were involved.

The only lateral processes in addition to the "transverse processes" are poorly developed metapophyses. In the *Zalophus* the width of the vertebrae decreases regularly from the first to the third. In the *Phoca* the greatest width of the first is considerably greater than in *Zalophus*, to allow for the broader apaxial musculature, and there is then a rather sharp constriction in width of the second. The transverse processes of the third and fourth, fused into a single plate, are again much broader, and the variation in this item must be due to some detail of the sacrospinal musculature that was not detected, for there is no difference in the origin of any of the hip or thigh muscles sufficient to account for it.

Caudal vertebrae.—Flower and Lydekker (1891) give the number of caudals as from 9 to 15, while Thomson (1909) says that in 47 individuals of 14 sorts of pinnipeds there were between 10 and 12. In a single mounted *Monachus tropicalis* there are apparently 13, and in a *Phoca fasciata* of the National collection, at least 14, with the possibility that the terminal ossicle of the tail has been lost. Although possibly unusual, it is therefore not startling to find that there are 14 caudals in both *Zalophus* and my *Phoca*, these bones constituting respectively 24 and 35 per cent of the body length. In the *Phoca* the transverse processes of the more cranial vertebrae are broader, and the spinous processes are lower and broader craniocaudad.

THORAX

STERNUM.—In essential features the sternal complex of *Zalophus* and *Phoca* are largely similar. In these two skeletons all of the elements are articulated and the bony portions (exclusive of presternal and xiphoid cartilages) constitute in *Zalophus* 56, and in the *Phoca* but 37 per cent of the trunk length (41 in a cat). In the *Phoca* skeleton there is a long, slender presternal cartilage which is two and a half times the bony part of the sternum and 71 per cent of the whole manubrial complex. In the *Zalophus* a similar result has been attained but chiefly by anterior extension of the bony part of the manubrium. Thus, in the *Zalophus* the latter is 22 per cent (17 in the *Phoca*) of the bony sternum, but the presternal cartilage is insignificant, and but 30 per cent of the size of the manubrium proper. The presternum of *Phoca* projects relatively farther forward than in the otariid, however. The bony manubrium is longer in the latter (over twice the length of the first sternebra), but in both the first pair of costal cartilages arises from lateral processes, in the *Zalophus* caudad and in the *Phoca* rostrad of the middle of the bone. In the former there are six and in the latter seven sternebrae. In the *Zalophus* only, the last of these has a pair of broad facets for the attachment of the costal cartilages. In this genus the xiphoid or enciform bone is relatively shorter but its cartilage is longer than in *Phoca*.

RIBS.—As already mentioned, there are 15 pairs of ribs in both animals, which is normal for otariids and phocids, but *Odobenus* has only 14. Attachment to the vertebral column of the first 10 pairs is both capitular and tubercular, and capitular only in the case of the last 5. The relative stoutness and shortness of the first rib is more accentuated in the *Phoca*. In *Zalophus* the first eight pairs of costal cartilages are securely attached to the sternum, while in the *Phoca* there are nine, there being in this genus one more sternebra.

EXTREMITIES

PECTORAL GIRDLE.—This is incomplete in the pinnipeds, there being no clavicle. The scapulae of the *Zalophus* and *Phoca* are very different. In the former the supraspinous fossa is two or more times the size of the infraspinous, the coraco-vertebral angle is well defined, and the vertebral border extends definitely caudo-ventrad. In the *Phoca* there is no coraco-vertebral angle proper, this part of the scapula being evenly curved, and to this extent the supraspinous fossa is reduced. The gleno-vertebral part of the infraspinous space (so termed to differentiate it from the more circumscribed infraspinous fossa proper, from which arises the muscle of this name) is much lengthened, giving to the scapula its characteristic sickle

shape. This places the vertebral border almost parallel with the body axis. In the *Zalophus* there is an epiphyseal cartilage all along the vertebral border, in the skeleton under consideration ossified only at the gleno-vertebral end. In the *Phoca* the only present indication of cartilage is the extensive gleno-vertebral projection, becoming more or less completely ossified with age. The degree to which this

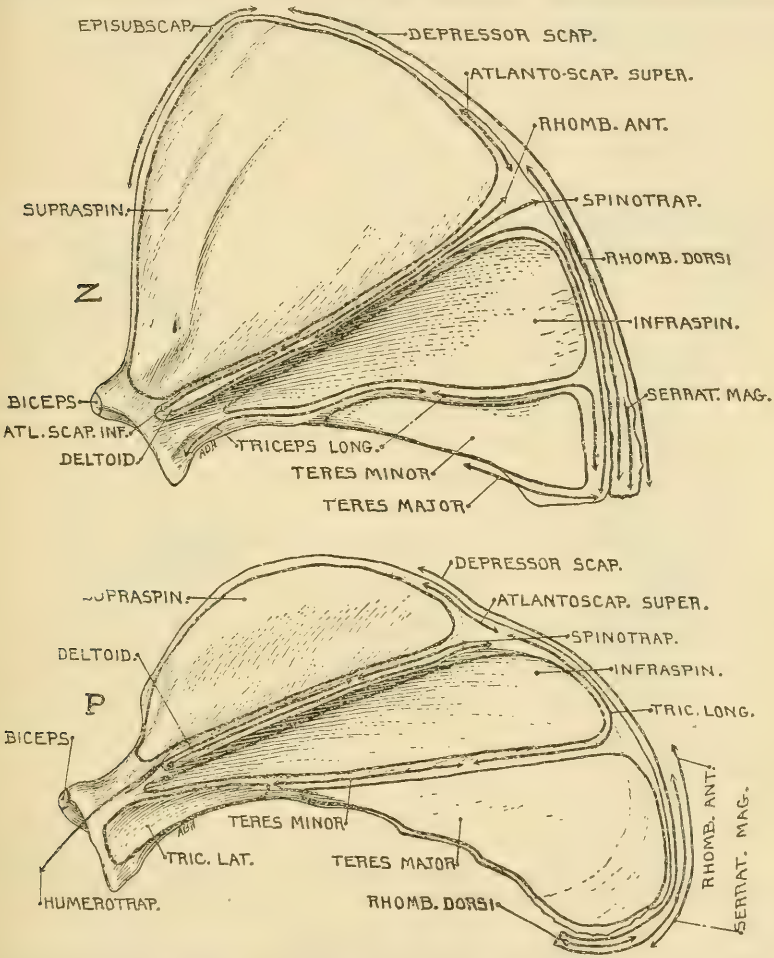


Fig. 7.—Lateral view of the left scapula of Zalophus (*Z*) and Phoca hispida (*P*) with areas of muscle attachments

condition obtains within the Phocidae is unknown at present because cartilage often is damaged or disappears entirely during cleaning of the skeletons. In the *Zalophus* the spine, placed not only relatively but actually farther caudad, terminates in a short acromial process, virtually absent in the *Phoca*, but it is difficult to give a myological reason for this difference. There is considerable generic variation

in the scapula. For instance, in *Mirounga* it is nearly of the form more often encountered in the Otariidae, and the supraspinous space is several times as extensive as the infraspinous.

There is such a large number of muscles attached to the scapula that it is impossible to sort out the different myological stimuli, and but a few broad generalities are practicable. The supraspinatus assists in extending the humerus, indicated as being considerably more powerful in *Zalophus.* The true infraspinous fossa, which occupies

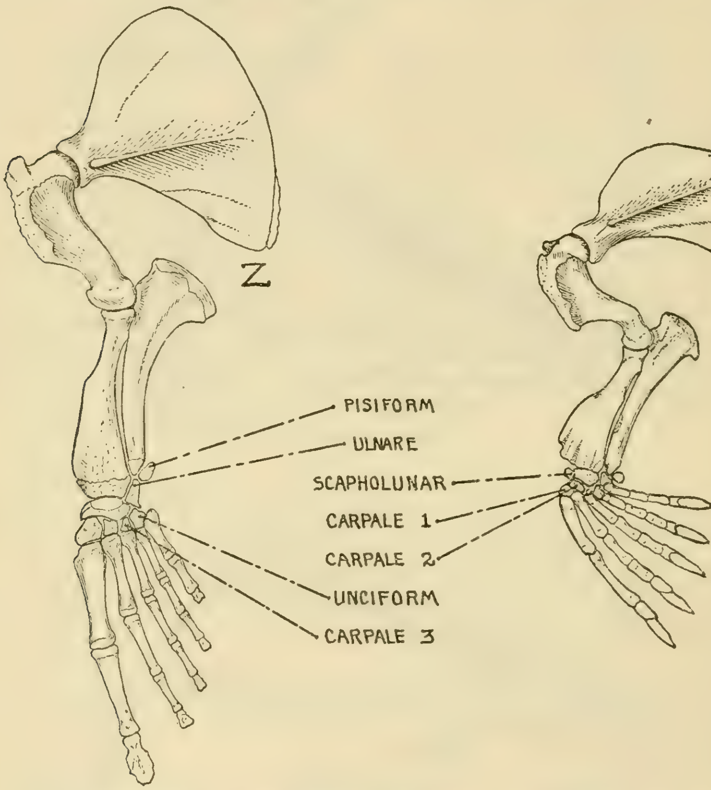


FIG. 8.—LEFT VIEW OF THE ANTERIOR LIMB BONES OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*) IN APPROXIMATE POSITIONS IN WHICH THEY ARE USUALLY CARRIED IN LIFE

about half of the infraspinous space, is more extensive in both animals than the size of the muscle warrants, and it is therefore doubtless in course of becoming still smaller. The infraspinatus is a rotator of the femur, with a slight flexor action in some mammals, but its leverage is small. This function has been assumed in the pinnipeds by the deltoid, which is especially remarkable in the otariids, and with much greater efficiency. Although the triceps is so highly specialized in the Pinnipedia this complex has not been

of prime importance in the modification of the scapula, and the long division in *Phoca* has not even taken full advantage of the extension of the gleno-vertebral angle. In fact, the rhomboids and serratus magnus, rather than any muscles more intimately of the shoulder girdle or brachium, have been chiefly instrumental in this gleno-vertebral extension. In *Phoca* the "teres major fossa," occupying the more caudal division of the infraspinous space, is large; in *Zalophus* it is much smaller and occupied by the origin of the teres minor, while the teres major has been segregated upon the border of the bone adjoining the angle, with limitations well defined osteologically. Between the teres fossa and the infraspinous fossa proper is a slight ridge, occupied in *Zalophus* exclusively by origins of triceps divisions, and in the *Phoca* by the teres minor also. In neither animal is there a true coracoid, but only a faintly indicated bicipital process upon the cranial margin of the glenoid fossa, from which arises the biceps. The angle of the scapular spine in relation to the glenoid fossa is the same in both.

Anterior limb.—In the Pinnipedia the functional length of the arm is so termed only because I am using this standard of comparison in the investigation of other mammals, and it signifies merely such a standard. Because most of the arm is within the body, and, furthermore, because in the *Zalophus* there are cartilagenous extensions of the digits, this functional arm length, so termed, bears an unknown relation to the effective lever power of the forelimb, which is discussed elsewhere. This length of arm then, which is of great value from a phylogenetic viewpoint, consists of the distance from the tip (exclusive of the nail in *Phoca*) of the first digit to the proximal termination of the radius, plus the length of the humerus, from trochlea to head. In the *Zalophus*[3] this comprised 66 and in the *Phoca* 48 per cent of the body length (82 in a cat); or, expressed differently, relative to body length, that of the *Phoca* was about 72 per cent as long as in *Zalophus*, a disparity still further increased during life by the presence in the otariid of cartilagenous extensions upon the digits.

Upper arm: *Humerus*.—In the *Zalophus* the humerus comprised 27, and in the *Phoca*, 30 per cent of the arm length (38 in a cat). Because of the disproportionate length of the manus in the former animal this comparison is not as significant as is the humero-radial comparison, which in the otariid was 95 and the phocid 104 per cent. Of the body length the humerus comprised 18 and 14 per cent, respectively (31 in a cat). The articular surfaces of the *Zalophus* are the more robust, relatively, and the fact that the normal position

[3] The manus and pes were disarticulated in the *Zalophus* skeleton, and the measurements computed after reconstruction upon sheets of modeling clay. They were not disarticulated in the *Phoca*.

of the humerus to the scapula is one of greater flexure in the phocid is shown by the position of the head, which in this animal was directed

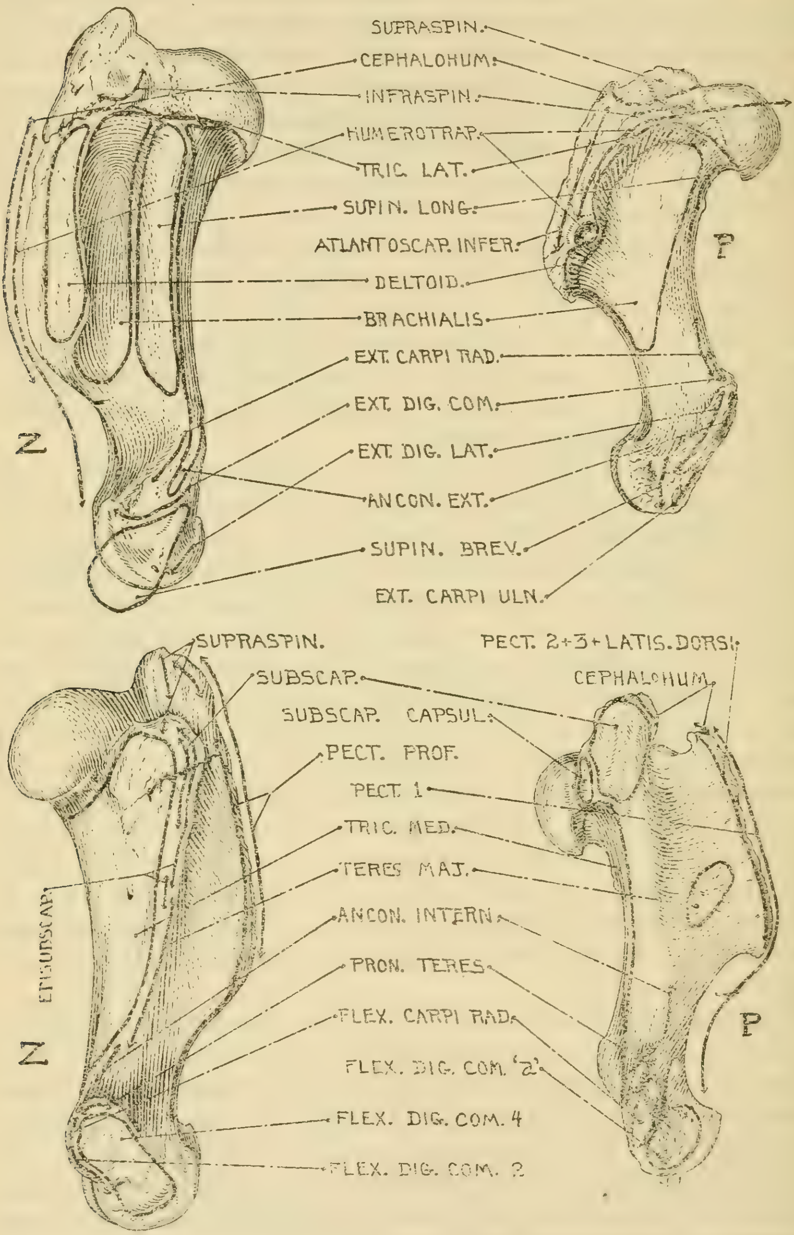


FIG. 9.—LEFT HUMERUS OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*); IN LATERAL VIEW ABOVE AND MEDIAL BELOW

more caudad of the shaft. The normal angular interrelationship of the different segments is indicated as nearly as possible in Figure

8. Except in shortness, the only way in which the two humeri show a marked resemblance is in the enormus development of the deltoid crest.

In the *Zalophus* the greater tuberosity is very massive and rises well above the head in an irregularly rounded knob, and distad it is prolonged into the broad deltoid crest, which extends for more than half of the shaft, and is raised from the shaft by a relatively thin wall of bone, which in the *Phoca* is thicker because of the lesser depth in that animal of the fossa from which arises the brachialis. In the *Phoca* the greater tuberosity is no higher than the head and the part adjoining the latter is relatively narrow, while there is a projection of bone stretching toward the lessor tuberosity, between which there extends a stout ligament as in many carnivores. The deltoid crest is relatively broader than in *Zalophus*—almost as broad as the shaft—the borders are more overhanging, and the distal termination extends no farther than the middle of the shaft. Upon the lateral border is a pit, of varying definition individually, for the reception of a separate tendon of the humerotrapezius. The only striking difference in muscle insertions that might account for the variation of the greater tuberosity is the much larger supraspinatus in *Zalophus*, but the chief reason is undoubtedly the different sort of work, and at a different angle, that the muscles of the two animals need to perform. The greater height in the otariid would allow of more powerful extension of the humerus. And the farther extension distad of the deltoid crest in this animal provides a greater leverage for the deltoid and pectoralis. In the *Zalophus* the lesser tuberosity, placed mediocraniad of the head, is very much lower than the head, but is massively rounded and its base gradually merges with the shaft. In the *Phoca* the homologue of the lesser tuberosity is phenominally developed, somewhat falciform, and higher than either the head or the "greater" tuberosity. Its base assumes more the form of a ridge. To account for these differences there is ample muscular variation. The subscapularis is of course inserted upon this tuberosity and it is evidently much better developed and hence more powerful in the phocid. In this animal a portion of the cephalo-humeral and the ligament between the tuberosities probably account for the falciform part of the lesser, while there is also insertion of the small subscapulo-capsularis, absent in the otariid, but the latter has the episubscapularis, which the phocid lacks. In final analysis, however, it is impossible to say that the diametrically opposed conditions of the two tuberosities in these two animals are due to this or that muscle.

The bicipital groove lies between the two tuberosities and this is relatively much the more capacious in *Phoca*. Within its channel, just proximad to the middle of the shaft, lies the teres major rugosity,

absent in *Zalophus*, for in the latter this muscle inserts narrowly upon the extended base of the lesser tuberosity. Just below the head in *Phoca* is a definite ridge, this being in line with the proximal extension of the entepicondylar ridge which marks the origin of the supinator longus. In *Zalophus* this origin is much more extensive and there is no ridge. In *Zalophus* the lateral epicondyle projects hardly laterad of the trochlea, but much more in *Phoca*, while in *Zalophus* the medial epicondyle is greatly developed and slightly so in the phocid. The only explanation which can be offered for these conditions is the inference that in the otariid the flexors of the lower arm, some of which arise from the medial epicondyle, are considerably more developed as regards angle of leverage and, therefore, effectiveness, than the extensors; and the flexors are the ones needed for powerful backward thrusts of the flippers in swimming. In the *Phoca*, however, it appears as though the stimulus for the development of the extensors has been at least as great as in the case of the flexors. The extensors are used in such motions as upward thrusts of the manus to assist in submergence or depressing the anterior part of the body. The *Phoca*, but not the *Zalophus*, has an entepicondylar foramen; but this is not a uniform character distinguishing the two families, for Thomson (1909) examined a number of skeletons of seven species and genera of the Phocidae in which this faramen was absent.

Forearm: *Ulna.*—Although the ulna of *Zalophus* appears the more massive, the greatest length of this bone is 123 in the otariid, and 131 per cent in the phocid (114 in a cat), of the articular length of the radius. The chief feature of this bone in the pinnipeds is its broadness proximad. In *Zalophus* the lesser sigmoid cavity is relatively deeper and the coronoid higher. A well-defined ridge occurs upon the lateral surface, separating the origins of the extensores metacarpi pollicis radiad, and the pollicis longus ulnad, the latter being about half the size of the former. In the *Phoca* the last-mentioned muscle occupies but a very restricted area near what is termed the ulnar process of the olecranon. This is considerably more falcate than in the otariid. Extending in *Phoca* from the radial process of the olecranon to below the sigmoid cavity is another small ridge, marking the insertion of the anconeus extrenus, but this ridge does not occur in the otariid and the muscle inserts by fascia upon the posterior border of the olecranon. Instead, there is a ridge farther radiad, marking with greater sharpness in this animal the lateral boundary of the triceps medialis. Just distad of the middle of the shaft from the lateral aspect there is a pronounced rugosity in the phocid but not the otariid, and in the former a corresponding one adjoining upon the radius marking a restricted but very strong

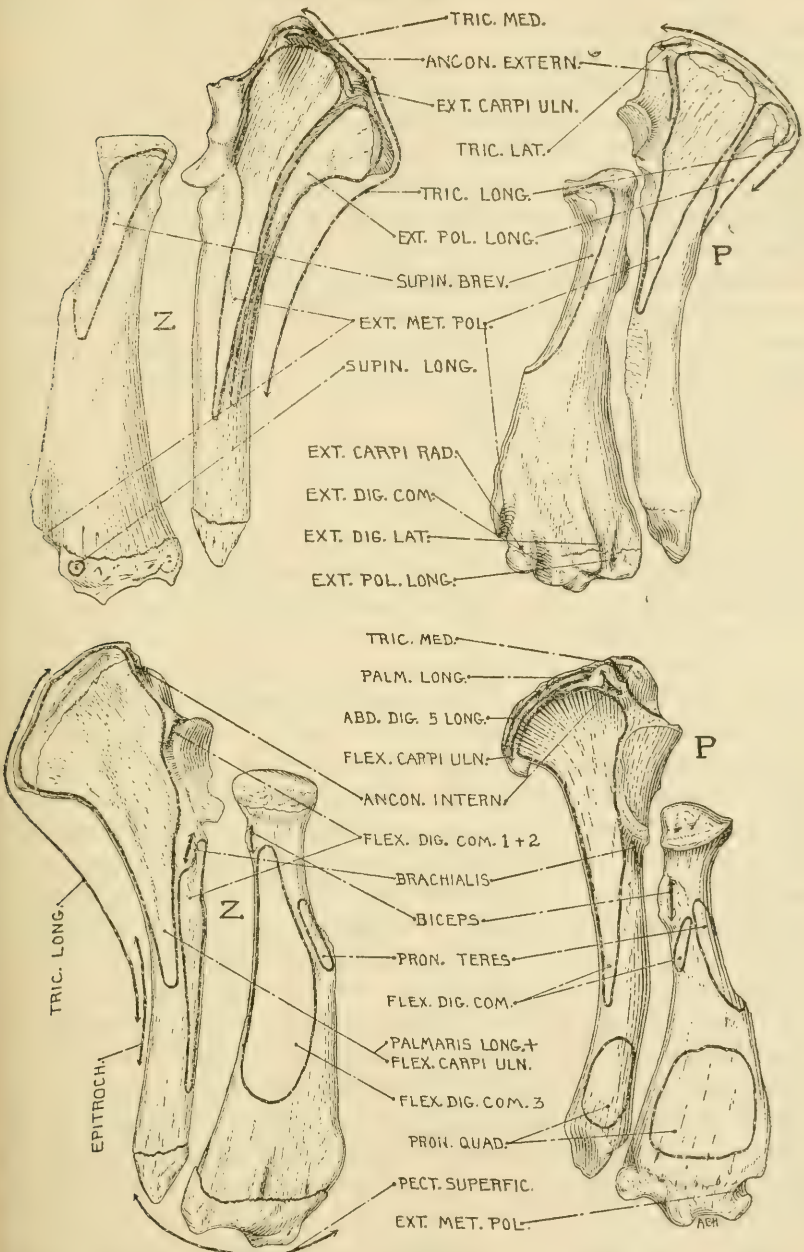


FIG. 10.—LEFT RADIUS AND ULNA OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*); IN LATERAL VIEW ABOVE AND MEDIAL BELOW

interosseous ligament, which occurs in *Zalophus* as the more usual and extensive interosseous membrane with little or no osteological indication. There may, however, be considerable variation in this detail.

The medial or flexor surfaces of the ulnas of the two pinnipeds are very similar, save for the relatively greater area proximad in *Zalophus*. In this animal practically all of this area is occupied by the origin of the very greatly specialized palmaris longus, and in the *Phoca*, by the second head of the flexor digitorum communis. Distad of the coronoid is the rugosity marking the insertion of the brachialis tendon, and still distad along the radial border, a slight crest in *Zalophus* only for the second head of the flexor digitorum communis. There are slight differences in the distal head of the ulna of the two animals, conforming to variation of the articular surfaces of the adjoining bones.

Radius.—In the *Zalophus* and *Phoca* the radius comprises about 20 and 14 per cent, respectively, of the body length (30 in a cat), 29 per cent in both of the arm length (36 in a cat), and 105 and 96 per cent, respectively, of the humeral length (104 in a cat). The most significant feature of this bone in the pinnipeds is the great expansion of its distal half. In the *Phoca* the bicipital rugosity is much the better developed, and there is also a well-marked rugosity for the interosseous ligament, absent as such in the *Zalophus*, as previously mentioned. The proximal part of the shaft is almost cylindrical, but at the center in the phocid and proximad thereto there is a pronounced expansion and process upon the radial side, which I have termed the "pronator teres process" because it is covered by the insertion of that muscle. The muscle, however, did not include any pronounced tendon or other feature which I considered would logically bring about the development of such a well-defined process. In *Zalophus* there are upon the flexor side of the distal part two broad, shallow grooves for two groups of flexor tendons, and upon the radial part of the extensor side, another for the extensor metacarpi pollicis tendon. Upon the flexor side in *Phoca* there are no grooves at all, but upon the extensor side these are numerous and deep. (See fig. 10.) This would seem to indicate that in the *Phoca* the somewhat specialized function of the extensor is in powerful recovery of the manus after flexion; which is in entire accord with the theory advanced partially to account for the greater phocid development of the lateral epicondyle of the humerus.

Hand.—The length of the manus, osteologically (not including terminal cartilage in the otariid nor the nail in the phocid), comprises 29 per cent of the body length in *Zalophus* and 19 in the *Phoca* (21 in a cat), while it measures 44 and 41 per cent, respectively,

of the length of the arm. From a functional standpoint this is not accurate, as the effective area of the manus in the eared seals is augmented by a considerable cartilagenous extension of the digits.

The nomenclature of the carpal and tarsal bones herein employed has been adopted after due deliberation, and is made up from the three methods of terminalogy (see, for instance, Flower and Lydekker, 1891, pp. 49 and 52) usually used in the cases respectively of the simpler reptiles and amphibians, in mammals in general, and third, human anatomy. Those terms are used which it is felt that the student who has not specialized in anatomy will most readily grasp and remember. The carpal elements, then, consist of scapholunar, ulnare, first, second, and third carpales, unciform and pisiform.

The proximal articular surfaces of the scapholunar and ulnare, and of the metacarpals of *Zalophus* extend slightly farther dorsad than in the *Phoca*. This, clearly, has been brought about by the usual position of the forefoot when the animal is on land, the otariid resting the anterior portion of the body upon the carpus, with the digits at a right angle to the forearm; while such a position is more rarely, and perhaps less decidedly, assumed by the Phocidae. In *Zalophus* the scapholunar is perhaps of unusual size, largely because of the great distal width of the radius. Carpale 1 is very large, probably not so much because it is primitive (Gregory, 1910) as that it has need to conform in size to the stoutness of the first metacarpal. Carpale 3 is the smallest of this series but is not pyramidal in form, and there is broad contact between the scapholunar and the large unciform. The pisiform occupies the angle between the radius and ulnare. The proximal extremeties of the first four metacarpals are approximately on a line, but that of the fifth is located markedly more proximad, articulating mediad with the unciform and to a very slight extent with the ulnare. The metacarpals do not lap one over the other, but there is an extensive articulation between the heads of the second and third.

In the *Phoca* there has been considerable reduction in the size of the carpus, and alteration in the relationship of the elements so as to allow excessive abduction of the manus. Carpale 1 is moderately large, but perhaps not when one considers the greater robustness of the pollex. The proximal end of the first metacarpal, however, is distad of the level of the middle three; in fact in dorsal view the proximal end of carpale 1 and of metacarpals 2, 3, and 4 are upon the same level. Carpale 1 reaches the scapholunar upon the palmar aspect but not dorsad, for between there is interposed carpale 2, which has broadened and lies between the first carpale and metacarpus two on the one hand, and the scapholunar upon the other. The second carpale is thus invisible from the palmar aspect; and the unciform is also much smaller from this view than it is dorsad, while

carpale 3 is markedly pyramidal, in palmar view being large and dorsad appearing as a restricted bony point. In the *Phoca* also the articulation of digit 5 with the unciform is upon the lateral side of that bone and considerably proximad of the level of articulation of the three middle digits. There is this difference, however; whereas in *Zalophus* the articular surface of metacarpus 5 is mediad, allowing the digit to point straight distad, in the *Phoca* it is proximad as in the other digits, and the fifth therefore is inclined to point laterad, making this digit, in fact, very much more "opposable" than is the pollex. The explanation for the narrow carpus in *Phoca*, and for the movement distad of the first digit and both proximad and laterad of the fifth, is probably that in the phocid the motions performed by the manus during swimming are of a pivotal, paddling type, much as are those of man when he is maintaining a static position in the water by means of his hands alone. The explanation for the movement distad of the pollex and both proximad and laterad of the fifth lies probably in the extreme amount of abduction of the manus in relation to the antibrachium, of which this pinniped is capable. In an articulated manus of *Monachus tropicalis* there is even more pronounced abduction in the normal position of the fifth digit, the first carpale is several times the size of the second, but the latter does not completely separate, in dorsal view, the first from the scapholunar.

In both animals the pollex is the longest digit and there is sequential reduction in length to the fifth, although this is much more pronounced in the *Zalophus*. In the latter the first metacarpal is much the longest and very much more robust than the others, and it is sharply flattened upon its medial border, possibly to assist a streamline form of the external surface of the flipper. In this animal it is slightly longer than the first phalanx of the same digit, while in the phocid the reverse is the case. In the otariid the fifth digit is much less robust than the first, but more so than the other three, while the third is a trifle the most slender. There is present a decided tendency toward the flattening of the digital elements which in the *Phoca* is encountered only to very slight degree in the pollex alone. Kukenthal (1890) reported indications of double epiphyses in the phalanges of the manus of several pinnipeds, both otariid and phocid. Such may be the case, but they are not convincing in the material at my disposal. In *Zalophus* the terminal phalanges are flattened and distorted in characteristic fashion and contain pits for the rudimentary nails. In the *Phoca* the broad, well-developed nails are retained in the cleaned skeleton.

PELVIC GIRDLE.—There are fundamental differences of a very interesting character existing in the innominate bones of otariids and phocids. The practical comparison of their measurements is rendered difficult, however, by the fact that in the earless seal the ilium

is bent laterad almost at a right angle to the remainder of the complex. The total innominate length in *Zalophus* is 21, and in the *Phoca* 26 per cent of the body length (25 in a cat); but the significant comparison is of the part craniad of the anterior lip of the acetabulum

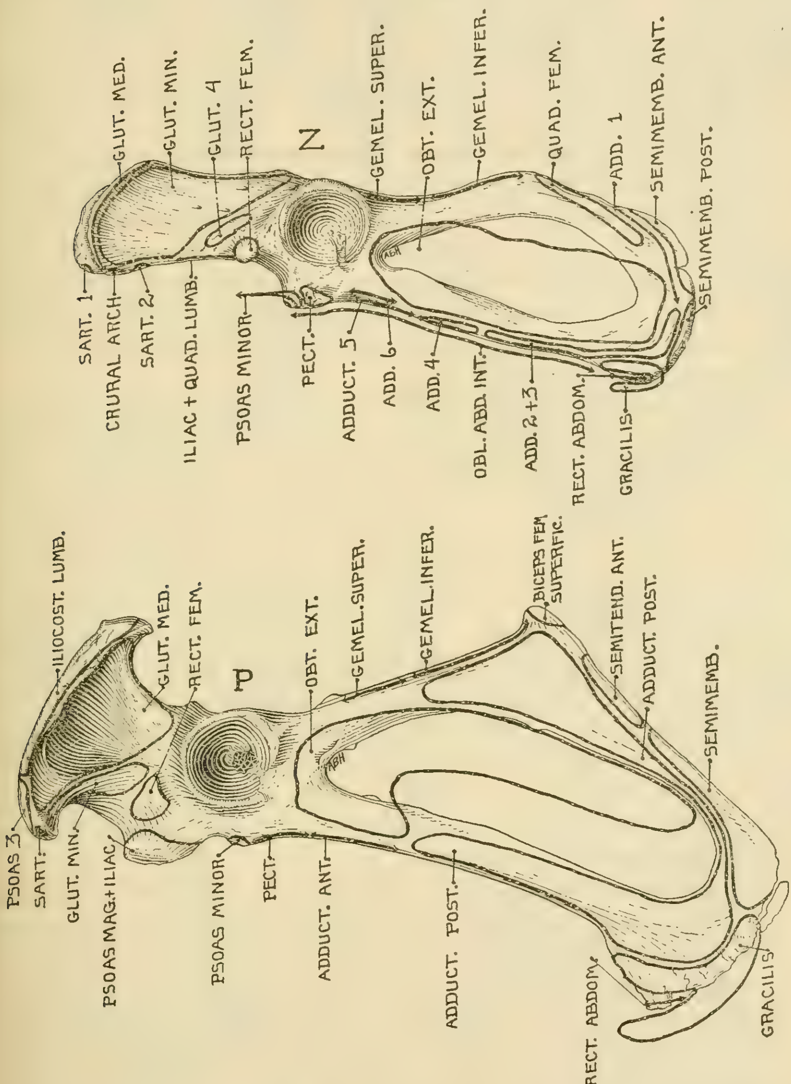


Fig. 11.—Left innominate bone of Zalophus (Z) and Phoca hispida (P)

with the portion caudad of the posterior lip. In the *Zalophus* this iliac part is 32, and in the *Phoca* but 16 per cent of the innominate length (59 in a cat), while a comparison of the pubo-ischiac portion gives a percentage respectively of 55 and 74 (33 in a cat). An analysis of these conditions is presented farther on. The sharp bend

laterad of the ilium in the *Phoca* has been caused chiefly by the iliocostalis portion of the back musculature, attached to almost the whole anterior (or "medial") face of the bone. As the femur is very short in this order, there is no need for a long ilium or long leverage for the flexors of the thigh. In both animals the insertions of the muscles extending from the posterior innominate to the knee and shank have migrated distad, and in order to increase the lever arm, there has also been a lengthening of the ischium and pubis. Why this should be marked in *Zalophus* is not so clear, for the muscles concerned are not of such fundamental importance to that animal; but this increased leverage—so well developed in the *Phoca*—is of basic importance in the adductional movements employed in swimming. In this animal there has also been some extension dorsad of the spine from which arises a part of the biceps femoris, which allows an elevation of the flippers in characteristic fashion, and ventrad of the inferior tuberosity of the ischium, adding to the effective range of movement.

The remainder of the muscular stimuli which operate upon the innominate are so complex and so involved with phylogeny and angles of leverage that a discussion in further detail is hardly justified. There may, however, be mentioned the greater prominence in *Zalophus* of the rectus femoris process, cranio-ventrad of the acetabulum, hardly more than a rugosity in *Phoca*. There is a single psoas-pectineal process in *Zalophus*, represented in *Phoca* by a large psoas magnus process, more cranially and ventrally placed, and a faint psoas minor process more caudad, while the pectineus arises from no prominence at all but has fleshy origin from the border of the pubis. There is no fused symphysis pubis in either animal, but this term is employed for convenience to designate this region; and there is an ischial epiphysis in both, located caudad and probably the more extensive in *Phoca*, but this is difficult to determine in the skeletons available.

Posterior limb.—The length of leg from a functional standpoint is of a questionable degree of value for the reasons not only that all but the pes is within the body covering, but also because the normal and more or less fixed position of the femur is flexed in the *Zalophus* and somewhat extended in the *Phoca*. The length of the hind limb is considered as constituting the sum of the lengths of the femur (head to condyle), tibia, and the distance from the tip of the second toe (exclusive of the nail in *Phoca*) to the posterior part of the astragalinar condyle. In *Zalophus* this is 62, and in the *Phoca*, 74 per cent of the body length (104 in a cat).

Thigh: *Femur.*—In the *Zalophus* the femur is 18 and in the *Phoca* 16 per cent of the limb (33 in a cat); of the tibia, 50 and 40 per cent; and in relation to the body length 11 and 12 per cent, re-

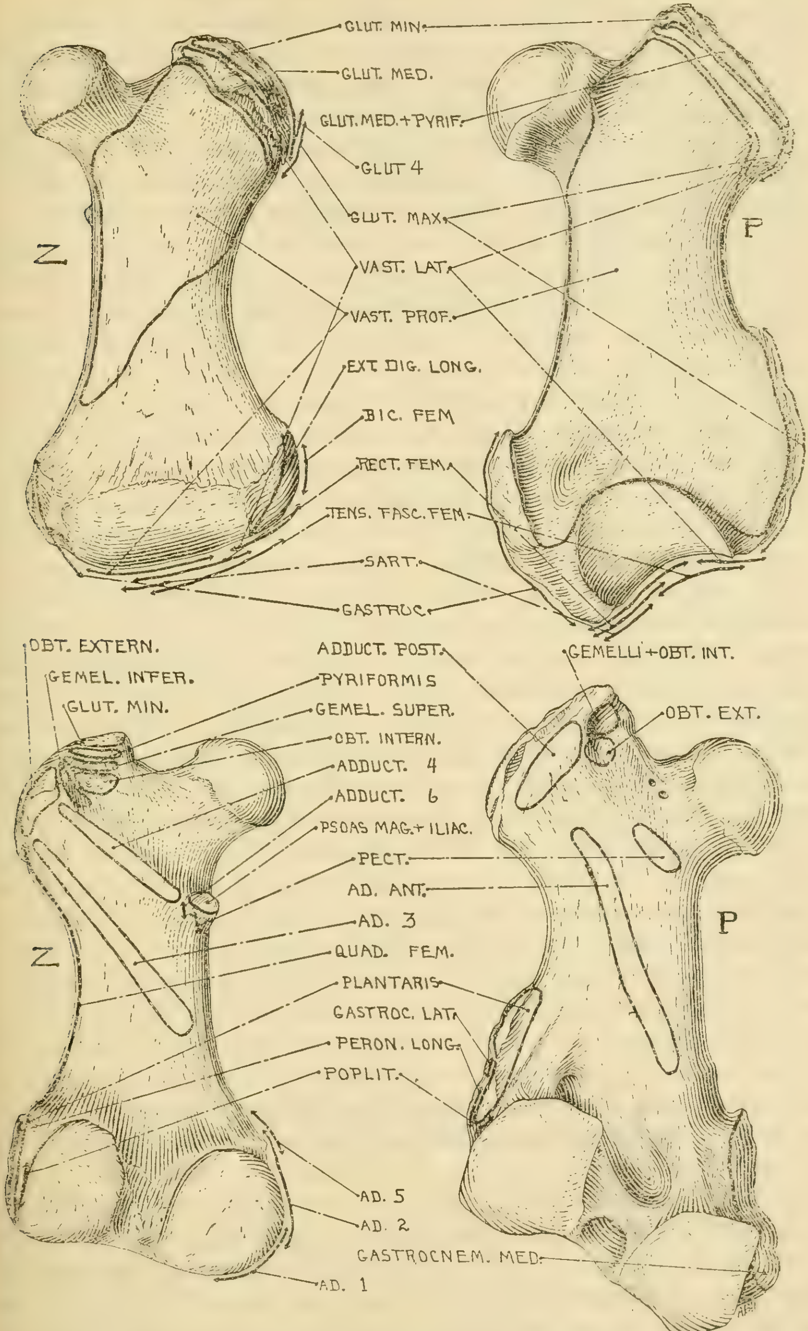


FIG. 12.—LEFT FEMUR OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*); ANTERIOR ASPECT ABOVE AND POSTERIOR BELOW

spectively (35 in a cat). Perhaps the latter comparison is the more significant from a phylogenetic aspect, although this is difficult to decide. In major details this bone is very similar in the two animals. The shaft is expanded laterally, being practically twice as broad in this direction as sagitally. The greater trochanter is laterad of the head and is greatly developed, as high as the head in *Zalophus* and slightly higher in *Phoca*. The summit of this trochanter in the latter is wedge-shaped and there is a deep and distinct trochanteric or obturator fossa, this being due to the tendency toward complete fusion of the tendons of the gemelli and obturator muscles which insert therein. In the *Zalophus* the insertions of all these muscles are separate, the trochanteric fossa therefore being less well defined and nothing but a shallow groove, reaching the summit of the greater trochanter, so that it has the shape of an inverted comma. *Zalophus* has a lesser trochanter, upon which insert the pectineus, adductor 6, and the psoas magnus and iliacus element. The *Phoca* has no indication of a lesser trochanter and in the situation corresponding to its position in the otariid there is only the somewhat extensive and fleshy insertion of the pectineus. From the lesser trochanter to the distal part of the greater there is in the *Zalophus* a slight ridge, marking the insertion of adductor 4, absent in the phocid. In the former the adductor 3, and in the latter the adductor anticus (probably homologous) is inserted in a line passing (approximately) from the medial epicondyle to the greater trochanter. There is in the otariid the suspicion of a ridge marking its location, corresponding evidently to the usual linea aspera. The epicondyles of the *Phoca* are the better developed, being broader, and extending farther proximad more in the nature of definite ridges. This seems to have been influenced by the better development in the phocid of the gluteus maximus, gastrocnemius medialis, and plantaris. In the *Zalophus* the patellar " fossa " is broad and slightly convex, while in the *Phoca* it is narrow and quite deeply concave. This detail varies considerably within the family, but it is probable that in the otariids the patella is never in quite as close relation to the femur as in phocids. In the small *Zalophus* dissected the femur was flexed to such a degree that the patella was situated at the apex of the angle formed by the thigh and shank segments and was almost entirely distad of the femur.

In the otariid the two condyles were of equal size, were directed exactly at a right angle to the shaft, and the outer was sufficiently proximad of the more medial so that a line passing laterad through the center of both would form an angle of about 79° with the axis of the shaft. In the *Phoca* the condyles were directed not quite so far as at a right angle to the shaft, the medial was but about two-thirds the size of the lateral, and a line through their centers would

form an angle of 63° with the axis of the shaft, thus placing the medial much more distad than the lateral. The reason for this will be discussed on page 127.

Lower leg: *Patella.*—The relation of the patella to the femur is discussed in the last paragraph. It is much more conical, especially in the Otariidae, than is the case with most mammals.

Tibia.—In the *Zalophus* and *Phoca*, respectively, the percentage of the tibia to body length is 22 and 29 (36 in a cat); to leg length, 36 and 39; and to the femur, 202 and 200 per cent (104 in a cat). The relative proportions of the thigh to the shank are therefore about the same in both animals. In the *Zalophus* this bone is relatively straight, robust, and with but slight constriction along the middle of the shaft. In the *Phoca* it is more curved and there is a greater constriction in the middle of the shaft. In this animal the posterior tibial fossa is deep and much better defined than in the otariid, and the anterior tibial fossa is but slightly indicated in both. In both the articular surface of the head is slightly altered from its normal position, the lateral part being situated a trifle more distad than the medial, this being more accentuated in the otariid. In the phocid there are nodular growths of bone about the border of the head, indicating some sort of pathologic condition. Distad the astragalar articular surface is much deeper and more cupped in the phocid and the medial malleolus does not project beyond the rest of the bone, as it conspicuously does in *Zalophus*. In the latter the grooves for the passage of tendons are very poorly defined, while in the phocid they are very deep, as they are in the radius. Craniad there is a deep one for the tibialis anticus, and caudo-mediad two, the more medial for the tibialis posticus and the other for the flexor digitorum longus.

Fibula.—The head of the pinniped fibula is solidly fused with that of the tibia and the distal extremeties of the two bones are immovably bound together by ligament. The fibular part of the common head is more or less on a level with the tibial part in the *Phoca* skeleton, but in the *Zalophus* it slopes very sharply distad, in this way providing for an excessive degree of flexion of the knee in this animal. That the condition of this detail is not uniform in the Phocidae is, however, shown by a skeleton of *Phoca groenlandica*, in which there is almost as much of a slope to the fibular head as in my *Zalophus*. The relative position of the heads of the two bones is about the same—perhaps a trifle farther caudad in *Zalophus*—but distad the fibula of the otariid curves quite far craniad, which seems never to be the case in the Phocidae. This changes the position of the ankle joint so that if both animals were normally plantigrade the otariid would toe in to a considerably greater extent than the phocid. The fibular shaft of the former is almost uniformly cylin-

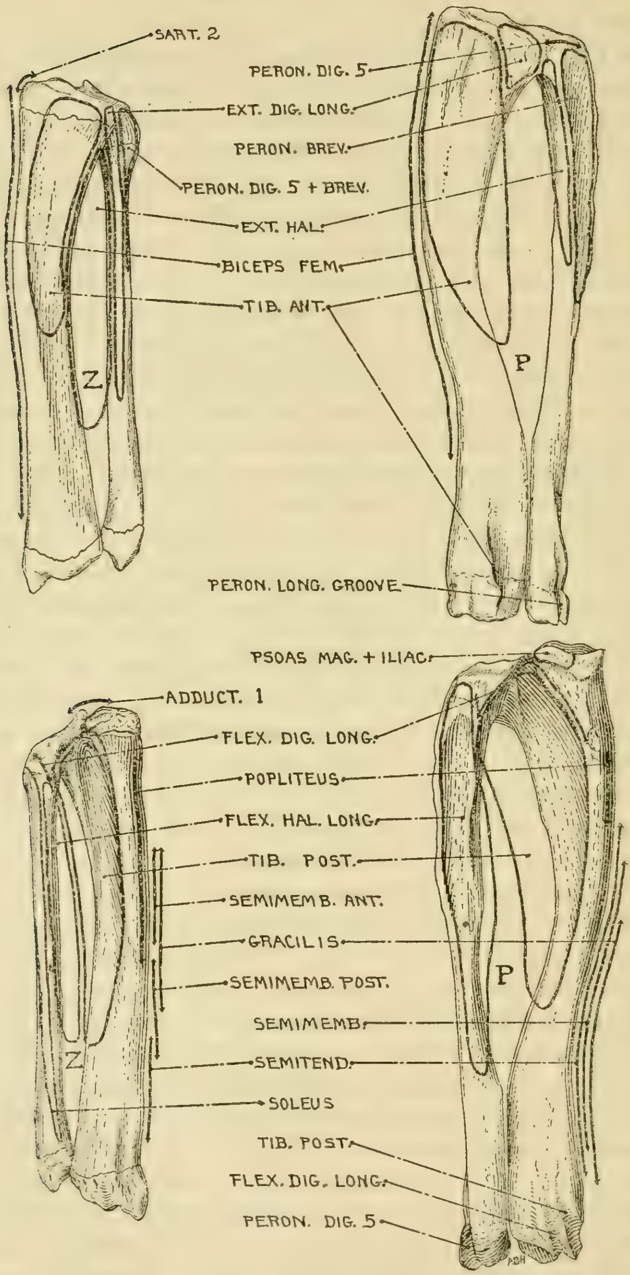


FIG. 13.—LEFT TIBIA AND FIBULA OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*); IN LATERAL VIEW ABOVE AND MEDIAL BELOW

drical, while in the latter it tapers from both ends toward the center, and there are two well defined fossae—one cranio-laterad, from which arises the peroneus brevis, and the other caudad, giving origin to the flexor hallucis longus. In the otariid the origins of both these muscles have a somewhat different relationship in regard to the fibula. The distal head of the otariid fibula is rather short, being definitely shorter than is the medial malleolus, relatively smooth and without grooves, and with but slight articulation with the ankle. In the *Phoca* the fibula projects distad of the medial malleolus, its surface for articulation with the ankle is almost as extensive as that of the tibia, and there are two very deep grooves laterad. The more caudal of these is for the peroneus digiti quinti, and the more cranial for the peroneus longus.

Foot.—If the osteological length of the foot for the present purpose be considered as comprising the distance from the tip of the terminal phalanx of the second digit to the caudal part of the condyle of the astragalus, then for the *Zalophus* and the *Phoca*, respectively, it constitutes 28 and 34 per cent of the body length, and 45 per cent of the leg length in both.

The tarsal elements of these two pinnipeds comprise astragalus, calcaneum, centrale, first, second, and third tarsales, cuboid, and a medial sesamoid. The astragalus is especially interesting and exhibits differences of much significance. In the *Zalophus* the position of this bone is slightly more dorsad of the calcaneum, the tibial facet is much larger than the fibular and its slope is more sharply ventrad, in part to compensate for the more distal position in this animal of the medial malleolus as compared to the lateral. This facet extends craniad in *Zalophus* only just onto the neck, and caudad in the *Phoca* only onto the posterior extension of the bone. From the fibular facet there is a broad process extending cranio-laterad, absent in the *Phoca*, and in the *Zalophus*, a constricted neck and expanded head, with an extensive, rounded facet for articulation with the centrale. In the *Phoca* the neck is of greater diameter than the head, and ventrad the articular facet is more extensive, a result of the greater degree of movement possible in this animal. In the *Zalophus* no part of the bone extends caudad of the tibial facet for a greater distance than a couple of millimeters. In the *Phoca* the astragalus is prolonged caudad in a truly remarkable process which extends beyond the termination of the calcaneum and is grooved for the passage of the flexor hallucis longus tendon. It is the tendon of this muscle only and its tension operating on the process of the astragalus, that prevents the foot of *Phoca* from assuming a position at a right angle to the shank.

The calcaneum of *Zalophus* is markedly constricted in the middle, being moderately expanded caudad and greatly so craniad, but that

of the *Phoca* lacks any such constriction. As might be expected from the great caudad development of the astragalus in the phocid the caudal process of the calcaneum is correspondingly reduced in robustness, which is not the case in the otariid. In the latter the anterior and posterior facets (the anterior and middle facets of man are fused in the Pinnipedia) are less extensive than in man, and still smaller in the phocid. Dorsad in the *Phoca* only there are two deep grooves, the more medial for the tendons of the peronei brevis and digiti quinti, and the more lateral for the peroneus longus. In the otariid only the expanded distal portion allows slight contact with the centrale.

The centrale of *Zalophus* is flat in a cranio-caudal direction but broad transversely, while in *Phoca* it is more irregular, is relatively narrow transversely and deep dorso-ventrad, making the narrowest

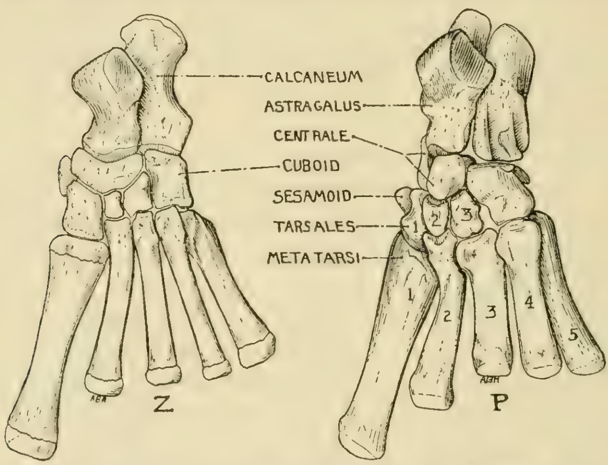


FIG. 14.—DORSAL VIEW OF LEFT TARSUS AND METATARSUS OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*)

part of the tarsus through the centrale-cuboid, while in the otariid it is across the neck of the astragalus and through the calcaneum.

The lateral part of the cuboid is deeply grooved in *Phoca* only, for the passage of the peroneus longus tendon, and the whole bone is not only more irregular in shape, but relatively a bit larger than in the *Zalophus*.

Tarsale 1 is very large, corresponding to the size of the hallux, but lies considerably more laterad (less dorsad) in the *Phoca*. In both animals tarsale 2 is slightly smaller than tarsale 3. Mediad to and fairly between tarsale 1 and the centrale of *Zalophus* is a well-defined sesamoid bone. It is mostly embedded in the tendon of the tibialis posticus but in adults its position is osteologically indicated by small but distinct articular facets upon both bones. In the *Phoca* dissected there was apparently no sesamoid occurring as a real bone,

but in the skeleton studied there was one, relatively as large as in the *Zalophus*, but in contact only with tarsale 1—not with the centrale.

In the otariid the four lateral metatarsals have responded to a transverse crowding and proximad are flattened in this direction, while the large hallux is very much flattened and transversely expanded. The fifth is slightly more robust than the three middle metatarsals. In the *Phoca* there has been equal or greater crowding proximad but the metatarsals have been less responsive, interlock to a much greater extent, and send a number of processes here and there. Another result of this crowding of the tarsal elements is the slight forcing in a plantar direction of the first, and more decidedly of the fifth, metatarsals of the phocid. It is apparent that in the latter there is some decrease in the mobility of the tarso-metatarsal articulations. As with the otariid the fifth metatarsal is slightly more robust than the three middle ones, and the first still heavier, but the difference in size is not so pronounced. In profile the dorsal outline of the metatarsals in this genus is markedly concave, to a conspicuously greater degree in this animal than the otariid.

In both animals the first and fifth digits are longer than the middle three and in the otariid there is a tendency toward flattening of the phalanges. Several investigators (as Kukenthal, 1890) have stated that all except the terminal phalanges of the pedal digits of the pinnipeds show distal as well as proximal epiphyses, in this respect approaching conditions in the Cetacea. As far as my own experience is concerned, there is but one small juvenal *Callorhinus* available which seems to have nodules of bone in the cartilage of the toe joints representing distal epiphyses. All other individuals at hand are sufficiently old so that no line of fusion at the distal ends of the phalanges can with certainty be traced. The middle three digits of the *Zalophus* have well-formed but slender nails, while those of the first and fifth are rudimentary. In otariids there is a terminal cartilage projecting in each pedal digit beyond the nail, and rather scanty material leads me to believe, for the present at least, that these cartilages are relatively longer in juveniles than in the adult. In the *Phoca* the nails are better formed, those of the first and fifth being larger than the other three. They project beyond the tips of the toes, as there are no terminal cartilages in this family.

MYOLOGY

In the following pages the comparisons are based upon the musculature of the *Zalophus* dissected, notations being made upon the muscles of the *Phoca* only when these showed details that differed. Attention is called to points wherein Murie's *Eumetopias* and *Odobenus*, or Miller's *Arctocephalus* and *Phoca* differed from the conditions in the respective families as I found them to be represented by

the animals dissected by me. But in some instances the above authorities—especially the former—omitted reference to certain muscles, or groups of muscles, and in other cases the descriptions were so involved as to be obscure. All details of differences are not given, of course, but only those of sufficient degree or quality to be deemed of some importance. The differences in origin and insertion of a muscle in the two animals are not always as great as indicated in the osteological drawings. Thus one investigator might consider that the vastus profundus (fig. 12) arises in *Zalophus* from only the proximal part of the femur, and in *Phoca*, in which animal there is slightly more tenacious attachment, that the origin is from the entire shaft, although in reality the muscular difference is very slight indeed.

As previously mentioned the *Zalophus* dissected was a juvenile and excessively lean, but its condition of preservation was excellent. The *Phoca*, on the contrary, was very fat and its condition poor, due in part to rupture of some of the blood vessels, especially about the shoulders, and consequent infiltration between the muscles of blood, the caked condition of which made dissection difficult at times. The coloration of the muscular tissue in these preserved specimens was about the same as in the usual fissiped, but it is common knowledge that the flesh of a freshly-killed pinniped, as well as of the Catacea, is unusually dark. As the flesh of the horse is of a similar color, however, this is not necessarily connected with aquatic specialization.

It may not be out of place here to mention that the musculature of the Pinnipedia does not differ as greatly from that typical of the terrestrial Carnivora as one might expect from the osteology, and there were but few times when I experienced any difficulty in readily homologizing the musculature to my satisfaction.

MUSCLES OF THE HEAD

1. SUPERFICIAL FACIAL MUSCULATURE

For the reason that Ernst Huber is making a separate study of the facial musculature of both specimens which I dissected, there will be but four of this group mentioned in the present report, this for the reason that they are intimately concerned with functions which it is wished to discuss.

M. platysma (fig. 15) was extensive in both *Zalophus* and *Phoca* but was not otherwise peculiar.

M. naso-labialis arose mediad of the anterior orbit and near the middorsum of the rostrum, diverging slightly fanwise, and inserting into the mystacial pad.

M. maxillo-naso-labialis (figs. 4, 5) arose from the zygomatic process of the maxilla caudad of the infraorbital foramen. In the Zalophus there was no osteological indication of origin, but in the *Phoca* the

muscle was considerably heavier and the point of origin is marked by a relatively deep fossa, but this is not present in all the Phocidae. Insertion was into the mystacial pad deep to the naso-labialis.

M. mandibulo-auricularis was a complex of several minute and slender muscles which were not separated. Origin was from the dorsal surface of the zygomatic root of the squamosal craniad of the auditory meatus, while insertion, seemingly more intricate in *Zalophus*, was about the auditory tube where this reaches the body surface.

2. MASTICATORY MUSCULATURE

M. masseter (figs. 4, 5, 6) was partially divisible in the *Zalophus* into two portions. The more superficial arose from the cranial third of the zygomatic arch and was inserted along the border of the mandible ventrad of the masseteric fossa, from just rostrad of this to the tip of the angular process. The deeper portion was inseparable craniad from the more superficial, and origin extended caudad as far as the tip of the jugal. Insertion was into the entire masseteric fossa of the mandible ventrad of the base of the coronoid process. In the *Phoca* this muscle was completely divisible, the more superficial arising from the full extent of the jugal, with insertion along the caudo-ventral border of the mandible from just rostrad of the angular process almost to the condyle. The deeper part arose similarly from the rostral end of the jugal caudad to the capsular ligament of the glenoid fossa. Insertion was upon the whole caudo-ventral half or more of the masseteric fossa of the mandible.

M. temporalis (figs. 2, 3, 6) of the *Zalophus* was divisible along its posterior portion into a superficial and a deep part. The former arose by aponeurosis from the medial border of the temporal fossa, rapidly thickened, and was inserted upon the lateral surface of the coronoid process, its more superficial fibers beneath the zygoma blending with the adjoining masseter. The deeper part arose from the entire temporal fossa and inserted upon the medial surface of the whole coronoid process. In the young animal dissected the temporals did not yet approach the middorsal line. In the *Phoca* the temporal was not divisible and was very much weaker and less extensive. Insertion was for a short distance upon the lateral, and upon the entire medial surface of the coronoid process.

M. pterygoideus externus (figs. 4, 5) arose in the *Zalophus* from the bony bridge over the alisphenoid canal, with insertion upon the roughened area directed cranio-mediad upon the medial condyle of the mandible. In the *Phoca* the origin was analogous, from the bridge of bone separating the foramina ovale and rotundum. Insertion was more robust, rostro-ventrad of the condyle upon the medial mandible. Miller found conditions similar in *P. vitulina* and *Arcto-*

cephalus, but the muscle was not mentioned by Murie for *Eumetopias* or *Odobenus*.

M. pterygoideus internus (figs. 3, 4) in the *Zalophus* was much larger than the externus, arising from the border of the bony wall of the interpterygoid fossa and practically coinciding with the extent of the palatal bone along this border. Insertion was below the condyle of the mandible. In the *Phoca* origin was similar save that it extended as far rostrad as the maxillary root of the zygoma. Insertion was along a ridge upon the medial side of the caudal border of the mandibular ramus that extended from the angular process to within a short distance of the condyle. Substantially the same for *P. vitulina* and *Arctocephalus* but not mentioned by Murie for *Eumetopias* and *Odobenus*.

3. INTERRAMAL MUSCULATURE

M. digastricus (figs. 4, 5, 6, 18, 19) was monogastric in both. In the *Zalophus* origin was from the whole lateral border of the paroccipital process, with insertion upon the caudal three-fifths of the ventromedial border of the mandible, extending also just laterad upon a slight prominence ventrad of the masseteric fossa. In the *Phoca* no tendinous division was noted, such as mentioned by Miller for *P. vitulina*, but origin was evidently the same, being from the depression upon the mastoid directly caudad of the center of the bulla. The muscle then spread so as to invest the entire audital bulla. The insertional end was much smaller than in the *Zalophus*, the attachment being to the medial side of the inferior border of the mandible, from the angular process craniad for several centimeters. Murie found a slightly tendinous division of the muscle in *Odobenus*, but not in *Eumetopias*.

M. stylohyoideus (figs. 18, 19) in the *Zalophus* was represented by but a few fibers deep to the digastric, extending from the region of the stylohyal, though not definitely from any part of the temporal bone, with insertion onto the basihyal. In the *Phoca* there was a very thin slip from below the auditory meatus to the basihyal, but superficial to the digastric, as in man. Miller gives this normal origin and insertion for this muscle in his phocids but fails to state its relation to the digastric. In my *Phoca* there was another slip upon the left side deep to the digastric, as in the *Zalophus*, but it seemed to pass entirely dorsad of the basihyal and disappeared in the neighboring tissue. It was noted as questionable in homology and when an attempt was made to verify it upon the right side it could not be found. Murie did not discuss the muscles of this region in his Otariidae.

M. mylohyoideus (figs. 18, 19) was normal for both *Zalophus* and *Phoca.* Origin was from the inner border of the lower jaw, with fibers passing caudo-mediad, and insertion was into the medial raphe and upon the basihyal.

4. MUSCLES OF THE TONGUE

M. mylohyoideus (figs. 18, 19) was normal for both *Zalophus* and arose from the connective tissue about the stylohyal and from a slight prominence upon the audital bulla. (Fig. 4.) It passed closely mediad of the diagastric and thence into the tongue. In the *Phoca* it was similar save that origin was from the inferior lip of the auditory meatus.

M. hyoglossus (figs. 18, 19) arose in the *Zalophus* from the thyro- and basi-hyal, deep to the mylohyoid, passing deep to the styloglossus and extending to the tongue tip. In the *Phoca* it was similar save that the origin was chiefly from the thyrohyal.

M. genioglossus was heavy in the *Zalophus* and arose chiefly from the basi- and cerato-hyals, with relatively few fibers from the lower jaw. Insertion was into the tongue as usual. In the *Phoca* origin was from the lower jaw only, with no direct connection with the hyoid. In this animal there also seemed to be elements of a chondroglossus muscle, represented by fibers passing from the thyrohyal into the tongue. For *P. vitulina* and *Arctocephalus* Miller reported the usual attachments to lower jaw, hyoid and tongue.

MUSCLES OF THE BODY

MUSCLES OF THE NECK

Superficial group.—***M. sternomastoideus*** (figs. 2. 5, 18, 19) in the *Zalophus* arose narrowly from the presternal tip and by fisciculi from its antimere (the juncture being free from the muscles beneath) as far craniad as the thyroid cartilage. Insertion was fascial and along the lateral third of the occipital crest adjoining the cephalohumeral, and more tendinous upon the mastoid process. In the *Phoca* the origin was located more caudad, it being from the border of the presternum, and insertion was limited to the mastoid process. Miller described for *Arctocephalus* a part of the sternomastoid which was utterly unlike anything which I encountered. In addition to the sternal origin, he stated that a part arose from the deltoid ridge of the humerus and from the fascial slip representing the clavicle. The latter part may be homologous with what I am terming the cleidomastoid; but in another place Miller said that it constituted the omohyoid, which, because of its insertion, is hardly

likely. From Murie's text I am unable to judge of the precise degree of resemblance with *Eumetopias* and *Odobenus.*

M. cleidomastoideus (figs. 2, 4, 18) was found in the otariids only. In two it was slender and had origin by fasciculi from the cranial border of the broad or posterior division of the cephalohumeral—this representing the clavicle. Insertion was chiefly tendinous upon the mastoid process adjoining that of the trachelomastoid. No mention of this muscle in *Eumetopias* was made, but Murie found it in *Odobenus.*

Supra- and infra-hyoid group.—***M. omohyoideus*** (fig. 18) was fairly well developed in the *Zalophus.* Its origin was inseparable from the deep half of the cleidomastoid, thus arising from the border of the cephalonumeral, this representing the clavicle. It passed beneath the sternomastoid and was inserted upon the basihyal. I do not consider that it was present in the *Phoca*, but Miller says that in *P. vitulina* it was a part of the sterno-thyro-hyoid; and in *Arctocephalus* the outer margin of the sternomastoid, which latter is not to be considered seriously.

M. sternohyoideus et ***sternothyroideus.*** (Figs. 18, 19.) In the *Zalophus* the former had almost disappeared. There was a single thin muscle arising from the manubrium deep to the presternum with insertion chiefly upon the thyroid cartilage but a separate slip extended also to the hyoid superficial to the thyreohyoid. This was separable from the main muscle no farther caudad than the thyroid cartilage. In the *Phoca* these two muscles were inseparable at their origin from the lateral two thirds of the first costal cartilage. A single thin muscle band then extended rostrad separable into two parts, a superficial slip inserting upon the thyro- and basi-hyals, and a deeper to the thyroid cartilage. Miller said that in *Arctocephalus* the common origin was from the tip of the presternum.

M. thyreohyoideus (figs. 18, 19) was normal, stretching from the thyroid cartilage to the thyrohyal.

M. geniohyoideus (figs. 18, 19) in the *Zalophus* arose from a restricted area near the symphysis menti, and broadened to an insertion upon the entire basihyal. In the *Phoca* this was just reversed, for the origin was broader than the insertion, which latter extended but a few millimeters from the midventral line.

Deep lateral and subvertebral group.—***M. scalenus*** (figs. 18, 19). I regard the homology of the different divisions of the scalenus in the pinnipeds as too uncertain to render wise any attempt at present to call them anticus, medius, and posticus, and prefer to refer to them by number. In the *Zalophus* there were two divisions that were almost vestigeal. (*1*) arose from the third rib partly deep to the serratus magnus. It extended as a slender wisp of muscle to a weak

insertion upon the anapophysis of the fourth cervical vertebra. (*2*) was even weaker, extending from the first rib to the anapophysis of the fifth cervical, possibly with a few fibers to the fourth as well. In the *Phoca* there were three divisions. (*1*) arose by digitations from the third to fifth ribs. The one from the fifth arose deep to the most cranical slip of the serratus magnus. There was a dorsal slip superior to the most caudal digitation of the depressor scapulae and another ventral one, both arising from the fourth rib, besides a single ventral slip arising from the third rib. The fibers of all converge to form a tapering, cylindrical muscle which was strongly inserted by tendon upon the anapophysis of the third cervical only. (*2*) arose from the first rib and was inserted upon the anapophyses of the fourth, fifth, and sixth cervical vertebrae. (*3*) also arose

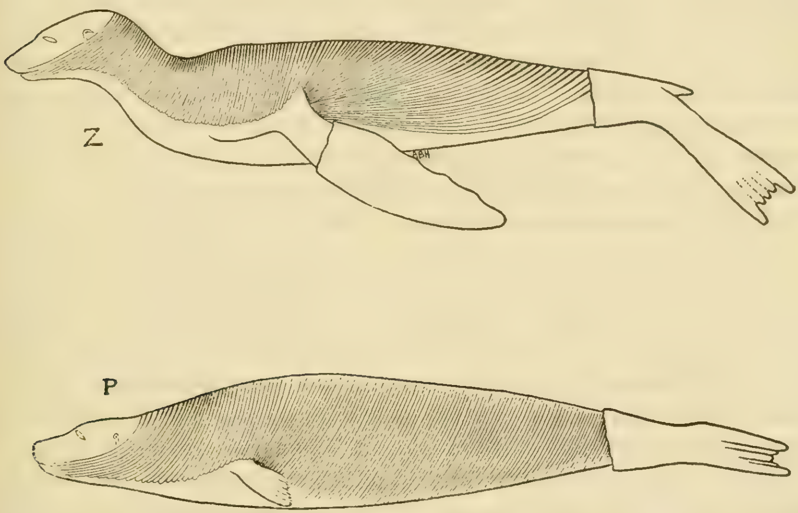


FIG. 15.—LEFT ASPECT OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*) SHOWING PLATYSMA-PANNICULUS CARNOSUS SHEET OF MUSCULATURE

from the first rib but dorsad of the second division. Insertion was by fibrous digitations upon the anapophyses of the third, fourth, fifth, and sixth cervicals. In *Eumetopias* Murie found that insertion of the two divisions was upon the sixth and seventh cervicals; in *Odobenus* that the muscle was single, from the third and fourth ribs to the atlas. Miller gave two divisions for *Arctocephalus* and three for *P. vitulina*. The latter was much as I found it in my specimen, save that insertion was said to be on the parapophyses of the cervical vetebrae. Both origins and insertions of *Arctocephalus* were given as very much more extensive than in my *Zalophus*.

M. longus colli in the *Zalophus* may be said to occur in three portions, but the anterior or atlantic one was exceedingly complex. Its cranial part lay directly laterad of the rectus capitis anterior major

and arose as follows: A ventral slip from the parapophysial plates of the fourth and fifth cervicals. A slip next mediad (separated from the last by a digitation from the posterior oblique division and by the two scaleni) arose from the anapophyses of the fifth and sixth and the parapophysis of the seventh cervical. The third slip arose from the anapophyses of the fourth, fifth, and sixth cervicals. The insertion of the depressor scapulae and slips of the transversalis cervicis then intervened dorsad. A fourth slip arose from the postzygapophyses of the fourth and fifth cervicals and a fifth slip from those of the third and fourth. Between the caudal ends of these two intervened a small part of the biventer cervicis. These five slips then converged to an insertion, largely tendinous, upon the transverse process of the atlas laterad to the inferior oblique. There was no anterior oblique and it is inferred that this division of the longus colli took its place. The second division was as usual, connecting the centra of the cervical as well as an indeterminate number of thoracic vertebrae. The third division or posterior oblique arose within the thoracic cavity from the first few thoracic vertebrae. It inserted by partially tendinous slips upon the parapophysial plates of the fourth, fifth, and sixth cervicals.

In the *Phoca* there were but two divisions. Origins of the first, or rather second, was from a number of the thoracic vertebrae (Miller says seven for *P. vitulina*). It then passed laterad of the rectus capitis anterior major and inserted by four tendinous slips upon the parapophyses of the third, fourth, fifth, and sixth cervicals. Dissection of the more anterior division was unsatisfactory because of caked blood, but origin was evidently from the medial part of the parapophyses of the third to sixth, inclusive, cervical vertebrae. Insertion of each bundle was upon the centrum of the vertebra next rostrad from the fifth cervical at least to the axis and probably to the atlas as well.

There were three parts to this muscle in *Arctocephalus*, and but two were mentioned for *Phoca vitulina*, *Eumetopias*, and *Odobenus*. In all of these the divisions were relatively simple.

M. rectus capitis anterior major (figs. 4, 5) (longus capitis) in the *Zalophus* arose not only from the parapophyses of the third, fourth, and fifth cervicals, but from the centra of the axis and atlas as well. In the *Phoca* it was larger and origin was from the third, fourth, fifth, and sixth cervicals. Insertion in both was upon the mediocranial part of the basioccipital, mediad of the rectus minor. Miller's *Phoca* and *Arctocephalus* dissections agree with my *Phoca*.

M. rectus capitis anterior minor (figs. 4, 5) was very small, arising from the cranial base of the transverse process of the atlas. In both the *Zalophus* and *Phoca* insertion was upon the latero-cranial part

of the basioccipital, laterad of the rectus major. Miller found that in *Arctocephalus* origin was also from the axis.

MUSCLES OF THE TRUNK

Muscles of the thorax.—***M. panniculus carnosus*** (figs. 15, 18) was inseparable from the platysma. In the *Zalophus* the fibers of the latter extended directly ventrad over the scapula, and of the panniculus, converged progressively from the dorsal fascia toward the axilla, clear to the root of the tail. In the extended specimen the ventral border of this muscle passed over the hip, and therefore the knee, with a slight ventral sag, joined the dorsal border of the pectoralis, from which it was separable with difficulty, and inserted into the connective tissue distad of the medial elbow. In the *Phoca* a very different state of affairs obtained. There was no converging of the fibers to the axilla, but origin was somewhat laterad of the middorsal line and all fibers were uniformly directed ventro-craniad at an angle from the vertical of about 35°, covering the knee and extending almost to the base of the tail, in which vicinity the line of origin extended somewhat more dorsad. Insertion of the portion over the scapula was onto the fascia of the middle forearm, and of the remainder upon the fascia of the ventral surface slightly laterad of the midventral line.

Miller found the true panniculus very similar in *P. vitulina* but failed to indicate the degree of convergence of the fibers toward the axilla—a most fundamental point. The platysmal part of this sheet he divided in an unnatural manner, terming the sphincter colli profundus the pectoral panniculus, and the like. Similarly, Murie without a doubt confused his dissection of the panniculus of *Eumetopias*, and not only illustrated the true panniculus as extending in several different directions, due possibly to the "set" position of his specimen, but the parts of the facial musculature which extend over the neck (platysma, spincters colli superficialis and profundus) are shown in incorrect relationship.

M. pectoralis (figs. 9, 10, 18, 19, 20, 22) in the *Zalophus* was imperfectly separable into three parts. The superficial sheet occurred as a pars anticus, arising midventrad from as far craniad as the presternal tip and caudad practically to the fifth costal cartilage; and a pars posticus, arising midventrad from 50 mm. caudad of pars anticus to the xiphoid cartilage. Both of these divisions united and were inserted upon the tough fascia covering the distal palmar aspect of the forearm continuous with the fibrous sheet of tissue immediately beneath the skin of the palm. Muscle fibers ceased about at the wrist. The pars profundus had origin extending from the presternal tip to the xiphoid and converged to a tough aponeurotic insertion along the deltoid ridge of the humerus and the slight ridge extending there-

from to the medial trochlea and thence stretching onto the forearm. (See p. 79.) The part over the deltoid was again divisible at insertion, one fascial sheet extending deep to the other. It should be emphasized that in this genus the border of the panniculus carnosus is practically fused with the border of the pectoralis, forming a powerful sheet of muscle inclosing the trunk, which is of the greatest importance in the economy of the animal. This is very different from the condition in *Phoca*. In this *Phoca* the pectoral sheet was also partially separable into three divisions but in a different manner, and only toward insertion. Origin was from the midvental line from the tough tissue dorsad of the entire presternal cartilage and then ventrad of the whole bony part of the sternal complex. Thence caudad origin passed laterad of the midventral line gradually to the side near the hind limb. From these points the fibers converged to the axillary region. Here it was found that the sheet from the presternum and sternum had become the most superficial, with insertion upon the medial lip of the deltoid ridge, thence by fascia into the axilla, and in the opposite direction, as far as the forearm. There was a second, lateral part, narrow and with the fibers coming from the region of the flanks, and in between these two a third division, the fibers passing deep to the other two and inserting with the second division and with the thicker, ventral part of the latissimus dorsi by a single tough aponeurosis upon the medial lip of the deltoid ridge, just deep to the first division. The sternal part of the pectoral complex was robust, while the abdominal part was thinner.

For *Eumetopias* Murie reported a single superficial pectoral (manubrium to fifth rib) inserting upon the proximal half of the humerus and to the axilla, and a second layer (first rib to xiphoid) with fascial insertion over the arm. In *Odobenus* he found a superficial division from the presternal tip to the xiphoid and ending in the fascia of the forearm, and a deeper, from the fourth costal cartilage to 6 inches caudad of the xiphoid, with insertion upon the whole length of the humeral shaft. In both of Murie's animals there was a narrow third division, not differentiated by me in *Zalophus*, from the manubrium, which merged with the first division. The differences in the pectorals reported by Miller are of a relatively minor nature. Suffice it to say that in this order the pectorals are exceedingly powerful and of great extent.

There is some question regarding the proper treatment in many mammals of the sheet of muscle of which the serratus magnus is a part. In the human the serratus is usually considered as comprising the entire muscle, but reference to the lower Mammalia indicates that it would be wiser to treat it as two muscles. This has at times been done, as by Reighard and Jennings (1901), who term the anterior division the levator scapulae, and I have therefore followed the

same course. This name now seems to me unfortunate, as the levator angulae scapulae is often so called and the two are entirely distinct. It therefore is preferable to refer to it according to its function which is a depressor of the scapula. In various animals this part of the sheet is variable, and purely for convenience it will be divided into a cervical and a thoracic part.

M. depressor scapulae (figs. 7, 18, 19) (levator scapulae part). In the *Zalophus* the cervical part arose by digitations from the anapophyses of the last five cervical vertebrae, directly adjoining the atlantoscapularis superior. It was continuous with the costal part, arising not by distinct slips but practically continuously from the fascia over the angles of the first four ribs. This part passed deep to the costal portion of the scalenus and together with pars cervicis the whole sheet was inserted along the entire vertebral border of the scapula save for about 25 mm. of its most cranial part. The caudal 25 mm. joined the broad tendon of the serratus magnus. In the *Phoca* origin of the cervical portion was the same and of the costal portion, from the ventral terminations of the bony parts of the first two ribs. Insertion was upon the medial aspect of the vertebral border of the scapula from opposite the spine caudo-ventrad around the glenovertebral cartilage. In *Eumetopias* insertion of this, as a part of the serratus magnus, included the atlas, this possibly being my atlantoscapularis superior.

M. serratus magnus (figs. 7, 16, 17, 18, 19) in the *Zalophus* was exceedingly powerful and was placed to best advantage for a backward pull of the scapula. Origin was by fascia from as far craniad as the second rib, thus overlying the depressor scapulae costalis for the distance of two intercostal spaces. Origin continued fascial to the fourth rib and thence to the tenth it was from the bony termination of each rib and the caudal border of its cartilage. The more ventral portion of the muscle was partly aponeurotic but it rapidly increased in thickness until near insertion it was some 10 mm. deep. The more dorsal fibers had an inclination directly craniad to the insertion, 25 mm. in length, upon the glenovertebral angle of the scapula. The anterior half of this was broadly tendinous, and being laterad of a part of the depressor scapulae, fibers of the latter also joined it. In the *Phoca* origin was from as far caudad as the twelfth rib. The digitation from the fifth passed over, and from the third and fourth under, the scalenus. It is doubtful if origin should be considered as reaching farther craniad than the third rib, as anterior to that the muscle sheet was of a much finer texture, but there was no discernible division between this muscle and the depressor scapulae. Insertion was as in *Zalophus*. Miller stated that in *P. vitulina* origin was from as far caudad as the tenth and in

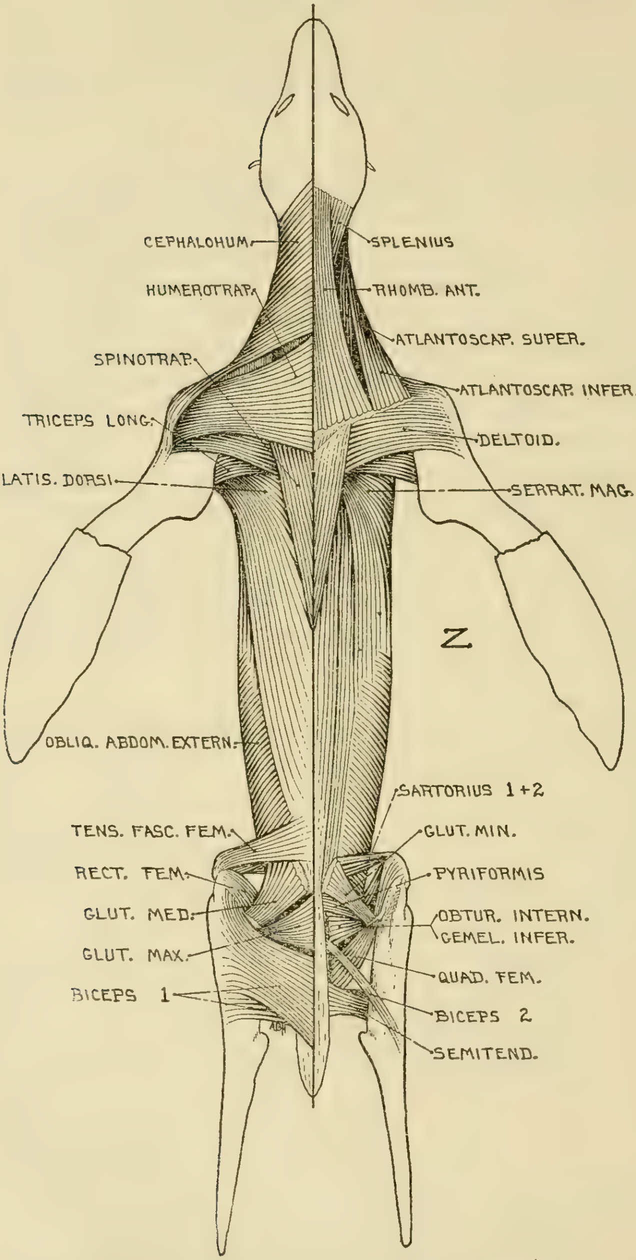


FIG. 16.—DORSAL MUSCULATURE OF ZALOPHUS; SUPERFICIAL LAYER UPON THE LEFT, AND MUCH OF THE NEXT DEEPER LAYER TO THE RIGHT OF THE MEDIAL LINE

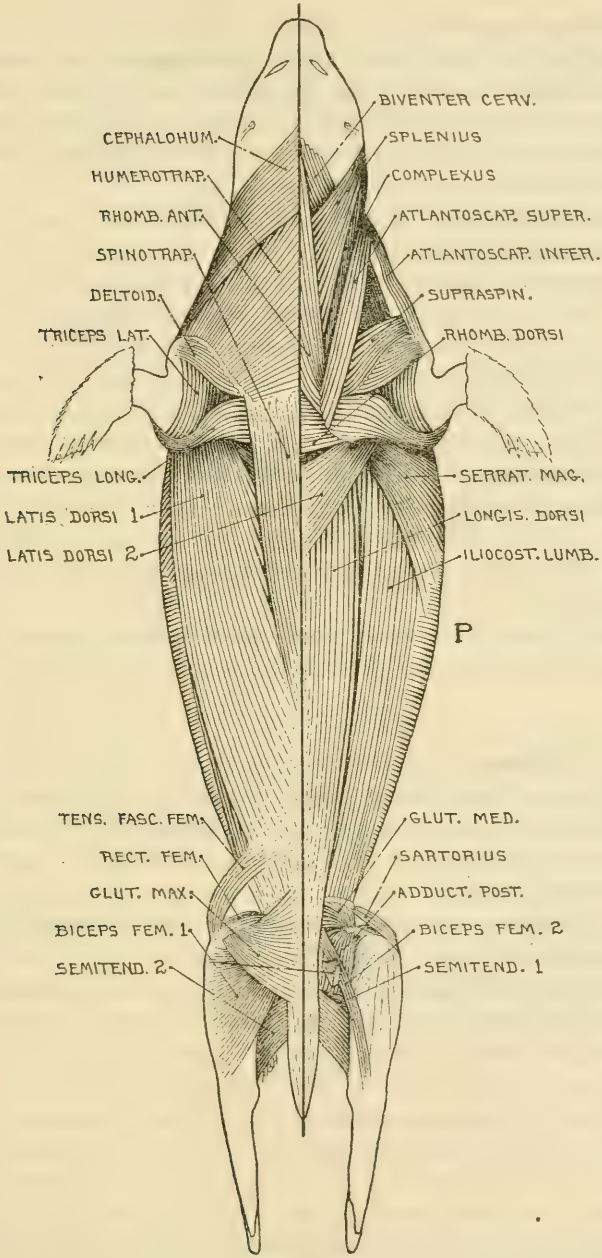


FIG. 17.—DORSAL MUSCULATURE OF PHOCA HISPIDA; SUPERFICIAL LAYER UPON THE LEFT, AND MUCH OF THE NEXT DEEPER LAYER TO THE RIGHT OF THE MEDIAL LINE

Arctocephalus, the eleventh rib. The description for *Odobenus* is obscure.

Mm. intercostales externi (figs. 18, 19) in the *Zalophus* were extensive and covered all the intercostal spaces except a part of these that lay deep to the sternocostalis. In the *Phoca* the external intercostals between the first three ribs did not reach much beyond the bony part of the costae, but caudad therefrom they gradually approached nearer the sternum.

Mm. intercostales interni exhibited no peculiarity save that the lateral fibers almost met over the ribs.

M. sternocostalis (figs. 18, 19) (supracostalis Murie, transversus costarum latus Lucae) in the *Zalophus* arose deep to the pectoral mass from the sternum between the first and fourth costae. Insertion was by two slips passing to the lateral (dorsal) part of the first and second costal cartilages. In the *Phoca* it arose from the manubrium and first two sternebrae, and insertion was upon the first costal cartilage. Miller reported this slightly more extensive in the animals which he dissected, but Murie found it essentially the same as I did. No sternocostalis posterior, such as Miller found in *Phoca vitulina* between the third and seventh ribs, was encountered by me.

Levatores costarum muscles were noted in both genera, but were not followed, nor were any of the muscles within the thorax sought.

MUSCLES OF THE ABDOMEN

M. rectus abdominis (figs. 11, 18, 19) in the *Zalophus* was rather weak. It arose from the symphysis pubis and adjoined the midventral line only as far craniad as the ninth rib. Thereafter slips inserted progressively upon the eighth, seventh, sixth, and fifth ribs, none of these being in contact with the sternum. In the *Phoca* it was relatively much broader and stronger. Discernible muscle fibers disappeared from its medial part at the fifth and from the lateral border at the third rib, from which point a broad tendinous sheet extended with a medial inclination to the sternum as far craniad as the first rib, but not to the presternum. In *Eumetopias* insertion was upon the sixth rib. Minor differences of insertion occurred in the specimens dissected by Miller, save that in *Phoca vitulina* the broad tendon of insertion also extended laterad to the humerus.

Because of excessive contraction of the thorax in the *Zalophus*, the other abdominal muscles were much wrinkled. They were thus very difficult to dissect, and as the preservation of this region in the *Phoca* was poor, all parts, especially craniad, were not completely investigated.

M. obliquus abdominis externus (figs. 16, 19) in the *Zalophus* originated from the last 10 ribs. From the sixth, seventh, and eighth the respective digitations were well marked, but caudad therefrom the slips were distinguishable only with difficulty, they being very tenuous and the fibers precisely parallel with those of the external intercostals. The digitations were not in direct conjunction with those of the serratus, but arose farther dorsad and deep to the latter. Origin was also from the deep dorsal fascia for a short distance. There was no Poupart's ligament, as there was in *Eumetopias* and hence no direct connection with the iliac crest, but a sheet of tough fascia running caudo-ventrad formed a part of the border of the inguinal canal and inserted upon the tuber of the pubis. Insertion was ectad of the rectus almost to the midventral line.

In the *Phoca* this sheet arose from the last 13 ribs, the first few digitations being rather involved in the relationship of their fibers. They were in contact with part of the scalenus, depressor scapulae, and serratus magnus. Caudad of the ribs the fibers of the dorsal border were parallel and in contact with the ilicostalis lumborum or lateral mass of the long system and connected to it by tough fascia. The innominate border developed a Poupart's ligament. Insertion was upon the midventral line ectad of the rectus. In *Arctocephalus* this muscle seems quite similar to *Zalophus* save that insertion is upon the brim of the pelvis, while that of *Phoca vitulina* is essentially similar to my *Phoca.*

M. obliquus abdominis internus in the *Zalophus* arose from the cartilagenous border of the thorax, from the deep dorsal fascia, from the crural arch, extending from caudad of the ventral crest of the ilium to the pectineal process, and then from the border of the pubis to within several centimeters of the symphysis. Insertion was upon the sheath of the rectus. That of the *Phoca* had a similar origin save that the attachment was to Poupart's ligament rather than the brim of the pubis direct. The fibers descended practically no farther ventrad than the border of the rectus, and inserted upon the aponeurotic sheet common to this and the transversalis. In *Eumetopias* the only innominate connection mentioned was with the crest of the ilium.

M. transversalis abdominis in the *Zalophus* arose by interdigitations with the fibers of the diaphragm, ostensibly as usual from the cartilagenous border of the thorax, the deep dorsal fascia, and with the internal oblique from the crural arch. Insertion was upon the deep part of the rectus sheath. In the *Phoca* this muscle did not extend quite to the innominate but the fibers stretched almost to the midventral line.

LUMBAR MUSCLES

M. quadratus lumborum (figs. 11, 24) in the *Zalophus* arose by slender bundles from the last three thoracic and all the lumbar vertebrae. The bundle coming chiefly from the anterior centrum of the penultimate lumbar extended upon the left side of the base of the femoral process of the ilium and its fibers fused with those of the iliacus. Upon the right side this slip of the quadratus inserted fully 2 centimeters farther craniad and was much more slender. In the *Phoca* origin did not extend craniad of the penultimate thoracic vertebra and I could not demonstrate that any of its fibers reached the ilium, but only the sacrum. The whole muscle was very much more robust than in the otariid.

MUSCLES OF THE BACK

Superficial, secondary back muscles.—***M. cephalohumeral*** (figs. 2, 3, 9, 16, 17, 18, 19) should perhaps be placed here. It is formed by the fusion of the clavotrapezius and clavobrachialis as in many carnivores lacking a clavicle. In the *Zalophus* it was rather complex and arose by three heads—a narrow one from the connective tissue just laterad to the tip of the presternum; next a second narrow one from the cranial margin of the deep pectoral, and third a broad head that extended rostrad from the fascia above the entire deltoid ridge of the humerus. The three heads joined and the broad, rather thin sheet of muscle resulting inserted along the medial two-thirds of the occipital crest and thence from the middorsal line as far as the humerotrapezius. Its chief action is probably in certain movements of the head, but in the *Phoca* this was reversed, and it operates rather to move the forearm. In this animal it arose as a tenuous sheet from the middorsal line as far rostrad as the interorbital constriction and caudad beyond the occiput. The fibers passed ventrocaudad over the side of the neck and converged to insert upon the lesser tuberosity and the adjoining portion of the greater as well. Miller stated that in *Arctocephalus* the more caudal attachment was to the humerus only. The condition of this muscle in his *Phoca* was the same as in mine, save that insertion was chiefly upon the greater tuberosity. In *Odobenus* caudal attachment was to the humerus only, but as near as I can tell the condition in *Eumetopias* was more comparable with that of *Zalophus*.

M. humerotrapezius (figs. 3, 7, 9, 16, 17) is homologous with the usual acromiotrapezius. In the *Zalophus* it arose from the middorsum adjoining and in the same plane with the cephalohumeral, the origin extending caudad over a part of the spinotrapezius. The fibers were directed latero-ventrad and it was free from the underlying spine of the scapula along the dorsal two thirds of the latter, but to the ven-

tral third it was intimately attached by fasciculi. Near the insertion its cranial border was overlapped by the cephalohumeral. It inserted, mostly deep to the latter, along the entire deltoid ridge of the humerus and its distal border extended even as far as the forearm, the fibers not ending in fascia but seeming to be incorporated with the supinator longus in company with the deltoid. In the *Phoca* this muscle did not overlie the spine. It arose from the middorsum from mediodorsad of the spine almost to the occiput, this being partially deep to the caudal border of the cephalohumeral. Insertion was robustly along the entire spine of the scapula and also by fascia along the caudal border of the deltoid ridge as far distad as a crater-like fossa, into which inserted a stout tendon which diverged from the humerotrapezius farther dorsad. For *Arctocephalus* Miller's description is not entirely clear, but the muscle seems to resemble that of my *Phoca;* and *Eumetopias* also conforms largely to this pattern—certainly not to that of *Zalophus.* On the other hand conditions in the latter genus were very similar to what Murie encountered in *Odobenus.*

M. spinotrapezius (figs. 7, 16, 17) was long and slender, arising from the middorsum toward the caudal thorax. In the case of the *Zalophus* there was a deep, tough aponeurosis upon which most of the fibers inserted, but more ectad there was a flat tendon developed and this ran cranio-ventrad to the spine near the ventral border of the muscle. That of the *Phoca* was similar save that the muscle fibers inserted directly upon the spine. In *Arctocephlus* insertion is said to be by the fibers blending with the dorsal surface of the deltoid.

M. latissimus dorsi (figs. 9, 16, 17) in the *Zalophus* arose from the dorsal fascia, extending from a few centimeters craniad of the glenovertebral angle of the scapula to the vicinity of the last rib. The anterior border passed superficial to the glenovertebral angle and the fibers of the whole sheet converged to two partially separable insertions—the more dorso-cranial one, representing perhaps two-thirds of the muscle, to a fascial insertion along the border of the teres major, and the other, to a fleshy insertion along the dorsal border of the insertional end of the pectoralis. For *Eumetopias* this muscle was reported as single, with insertion upon the bicipital ridge. Its insertion was not given for *Odobenus.* In the *Phoca* the dorso-cranial part was quite thin, with origin gradually from the dorsal fascia and fibers converging to the axillary tissue. The ventral part was rather abruptly 10 times as thick as the remainder, with insertion upon the deltoid ridge with the second and third divisions of the pectoralis.

M. rhomboideus anticus (figs. 2, 3, 7, 16, 17) in the *Zalophus* arose from the medial third of the occipital crest deep to the cephalo-

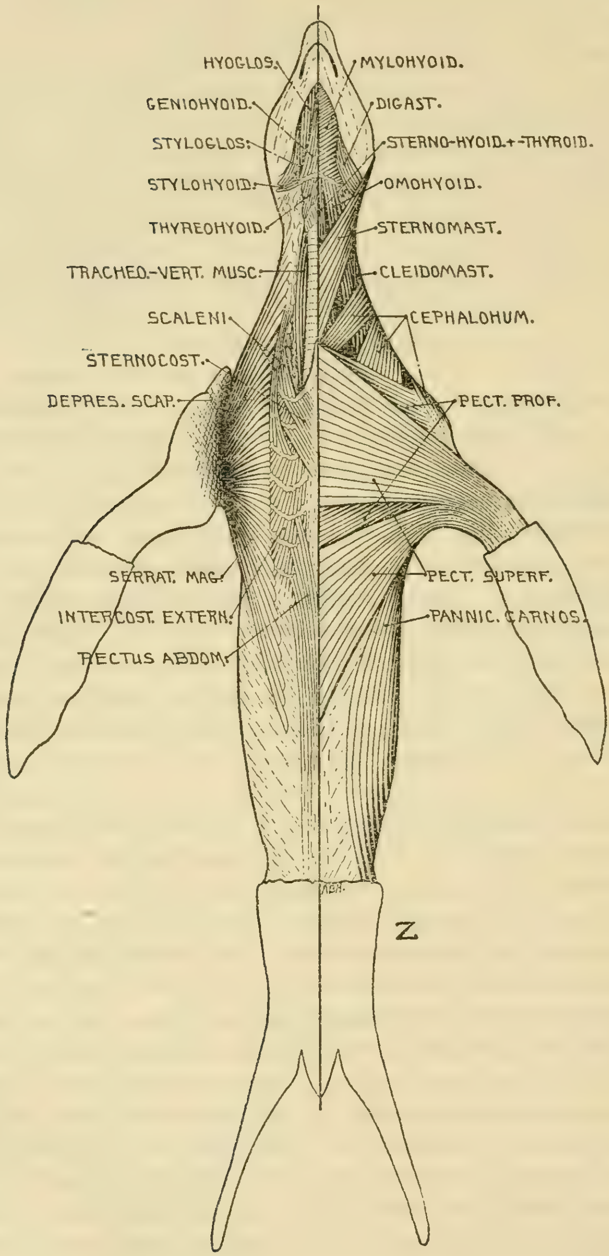


FIG. 18.—VENTRAL MUSCULATURE OF ZALOPHUS; SUPERFICIAL LAYER UPON THE RIGHT, AND MUCH OF THE NEXT DEEPER LAYER TO THE LEFT OF THE MEDIAL LINE

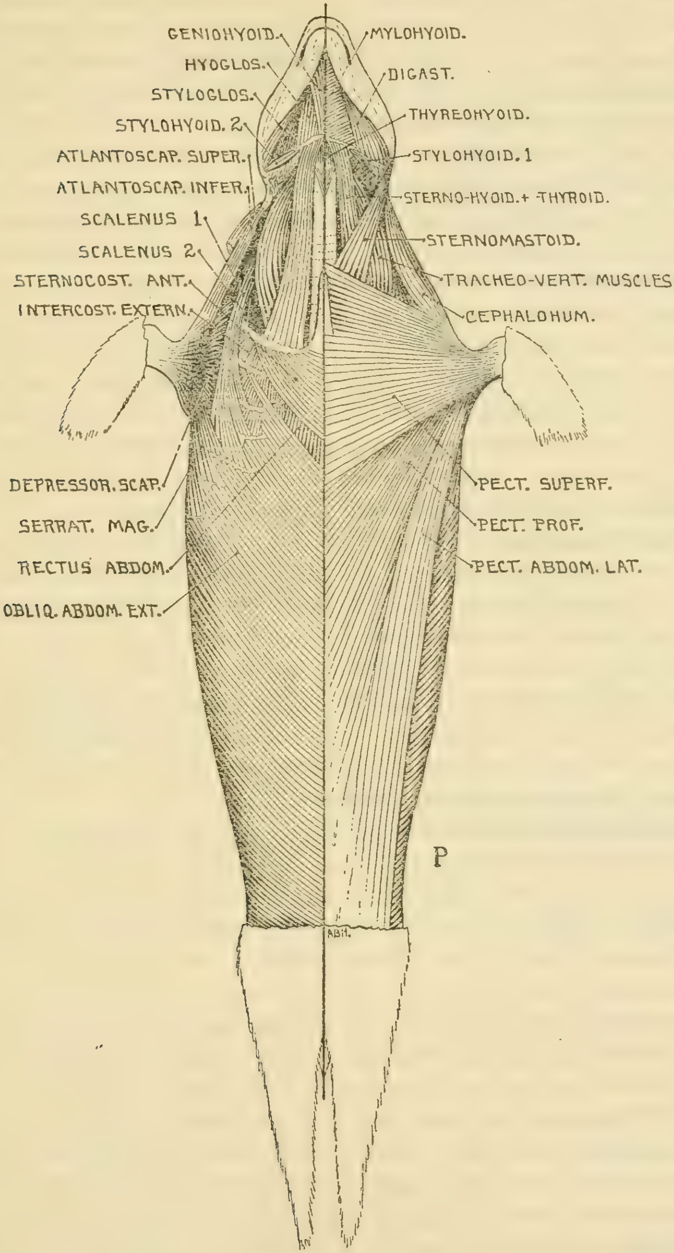


FIG. 19.—VENTRAL MUSCULATURE OF PHOCA HISPIDA; SUPERFICIAL LAYER UPON THE RIGHT, AND MUCH OF THE NEXT DEEPER LAYER TO THE LEFT OF THE MEDIAL LINE

humeral and inserted along the dorsal three-fifths of the spine of the scapula. In *Arctocephalus* this was called rhomboideus capitis by Miller and was similar to my *Zalophus*. According to Murie conditions were quite different in *Eumetopias*. He termed it rhomboideus capitis, with origin from the middorsum of the cervical and anterior thoracic region and insertion upon the dorsal part of the spine and the caudal half of the vertebral border of the scapula. In *Odobenus* it did not extend caudad of the spine along the vertebral border. In my *Phoca* origin was from the nuchal ligament as far craniad as the occiput. It passed deep to the vertebral border of the scapula and inserted along the caudal border of the glenovertebral cartilage, its fibers fasciculating with those of the serratus magnus. For his *Phoca* Miller described two anterior rhomboids—a capitis and a cervicis—but from his text I can not tell whether these were entirely separate muscles (one corresponding to an occipitoscapularis) or two divisions of what might be considered as a single sheet. Attachment to the whole vertebral angle of the scapula is indicated, but otherwise conditions were similar to my *Phoca*.

M. rhomboideus dorsi (figs. 7, 17) in the *Zalophus* arose from middorsad by interdigitations of its fibers with those of its antimere. It was a rather decadent muscle, and its coarse, loosely connected fibers ran laterad to insert upon the vertebral border of the scapula, from slightly craniad of the spine to the glenovertebral angle. Murie considered that this represents the major and minor divisions. In the *Phoca* it was similar, save that insertion was only by fasciculi into a part of the insertion of the serratus magnus along the ventral border of the glenovertebral cartilage.

M. atlantoscapularis superior (figs. 7, 16, 17, 19) in the *Zalophus* had origin from the transverse proceess of the atlas just entad of the inferior division of this muscle. It was slender and extended to aponeurotic insertion upon the vertebral border of the scapula for a short distance just craniad of the spine. Near the insertional end it was parallel to the fibers of the depressor scapulae and one can readily see that the two muscles might fuse, the sheet then being folded over the coracovertebral angle. Authors have expressed doubt, from time to time, that either division of this muscle as here termed is homologous with the human levator (anguli) scapulae. The innervation in a large number of diverse mammals will have to be investigated before this point is settled, but at any rate it would be theoretically easy for this superior slip to migrate ventrad along the anterior border of the scapula, or for the inferior slip to migrate on to the head of the humerus, as is actually the condition in *Phoca*, and then dorsad to the more usual levator anguli scapulae position. Conditions were the same in my *Phoca* save that insertion was dor-

sad of the spine. Not mentioned by Murie as a distinct muscle in *Eumetopias* but possibly included as a part of his serratus magnus.

M. atlantoscapularis inferior (figs. 7, 9, 16, 17, 19) also arises from the transverse process of the atlas, but superficial to the origin of the superior division. In the *Zalophus* insertion was by fascia upon the ventral two-fifths of the spine of the scapula adjacent to the anterior rhomboid and upon the neighboring part of the humerus. In the *Phoca* the insertion had migrated more distad and was by fascia upon the greater tuberosity and deltoid ridge of the humerus adjoining (ventrad of) the humerotrapezius. Miller called this muscle atlantohumeral in *Phoca* and atlantoscapular in *Arctocephalus*, according to the insertion. They are undoubtedly homologous and I prefer to employ the same term for both, even though it is slightly ambiguous in the case of the seal. It is the levator anguli scapulae of Murie. In addition the latter mentions, rather vaguely, an accessory slip in *Odobenus* which he considers to be the homologue of a levator claviculae.

M. serratus posticus. Deep to the rhomboid layer of the *Zalophus* and a couple of centimeters caudad to any part of the scapula was a tenuous, vestigeal bit of muscle which arose from fascia and ended likewise beneath the caudal border of the larger rhomboid. I did not distinguish it in my *Phoca*, possibly because of the presence of clotted blood in this region, but Miller did in his. It has not been reported from any of the other eared seals proper, but Murie found it fairly well developed in *Odobenus*.

Deep, intrinsic back muscles.—***M. splenius*** (figs. 2, 5, 16, 17) arose from the middorsum, extending in the *Zalophus* from the occiput to about the second thoracic spine, and inserting along the entire occipital crest, from the vertex to the mastoid process, at the latter point being continuous with the trachelomastoid. In the *Phoca* origin extended craniad only as far as the spine of the axis, and insertion was limited to the mastoid process. This is Murie's splenius capitis.

M. erector spinae, sacrospinalis, extensor dorsi communis or long system of the back was but moderately developed in the *Zalophus*, and the pair of muscles together in the specimen dissected measured but 100 mm. in width at the widest part in the posterior thoracic region. It was indivisible in the lumbar region, the whole muscle arising from the vertebrae, sacrum, and inner surface of the ilium. Between the ninth and sixth ribs it was partly separable into an iliocostalis dorsi and longissimus portion, but craniad to the sixth rib these once more to all intents constitute a single muscle. This fused part sent a slip to each of the first 10 ribs and to the anapophyses of each of the last five cervical vertebrae, this part at least

representing a longissimus cervicis. Mediad, and craniad of the fourth thoracic vertebra, the biventer cervicis intervened, and adjoining the spines was the spinalis dorsi, distinguishable with clarity craniad of the eighth rib. The spinalis cervicis portion of this inserted upon the cervical spines to and including the axis.

In the *Phoca* this was an astonishing mass of muscle, the two sides together measuring 210 mm. in width, and a definite impression was gained that although enormously stronger than in the eared seal dissected, its normal uses were for less complicated and more restricted in movements. Caudad it was clearly divisible into a medial longissimus dorsi and an iliocostalis lumborum of slightly lesser width. These two, however, were not separable with any degree of east throughout their deeper portions. The superficial fibers of the iliocostal part were seen to arise from the glistening aponeurosis covering the longissimus, but the chief origin was fleshy and from almost the entire cranially-directed surface of the "medial" border of the ilium, forming an attachment of enormous strength. Within 50 mm. of this bone the iliocostal had attained a width of 40 and a depth of 45 mm. More craniad there was fibrous connection with the ribs over which it passed until a tendinous slip was given off to join the seventh, but apparently no other ribs in that vicinity. The muscle then broadened and developed tendon bundles, five of these passing cranio-dorsad to join the transverse processes of the first five thocacic vertebrae and four others cranio-ventrad to join the first four ribs. Thus, the anterior part of this muscle was simple, doing little but acting as an anchor for the posterior part. In the posterior thoracic region the longissimus had rather obscure spinalis dorsi elements, there being tendons extending cranio-mediad to join each spine, but no distinct muscle could be separated. In its more lateral part the longissimus had slight fibrous attachment to the ribs and mediad there were tendons gradually developing from the transverse processes extending craniad to be lost in the muscle mass. These increased in size in cranial sequence from the last thoracic and the series culminated in a very strong tendon from the tenth after which these ceased. Thus, these tendons seemed to be largely instrumental in the development, upon these thoracic vertebrae only, of distinct metapophyses and constituted a semispinalis dorsi element. There were also smaller longissimus tendons of opposite inclination attached to the anapophysis of each vertebra. At about the seventh thoracic the longissimus split into two parts, both rapidly becoming slender. The more medial was the spinalis dorsi, becoming the spinalis cervicis. Its attachments were by fasciculi to the spines as far as the fourth cervical, although a few fibers may have extended still farther craniad. The more lateral division was the longissimus

(transversalis) cervicis. It sent tendinous slips to the transverse processes of the first four thoracics and was tucked in laterad of the trachelomastoid, inserting upon the dorsal part of the anapophyses of the last four cervicals.

M. trachelomastoideus[4] (figs. 2, 5), or longissimus capitis, although a part of the long system morphologically, had better be considered a separate muscle. In the *Zalophus* it arose from the postzygapophyses of the last four cervical and first two thoracic vertebrae, and insertion was strongly upon the mastoid process continuous with that of the splenius. In the *Phoca* origin was from the third to seventh (inclusive) cervicals. Miller reported that in his *Phoca* the muscle was partially divisible, a second slip inserting upon the transverse process of the axis; but nothing like this occurred in my specimen. In *Arctocephalus* origin was from the last five cervicals only; in *Eumetopias* from the fourth and fifth and in *Odobenus*, the fifth and sixth thoracic spines, according to Murie, who terms this the splenius colli.

M. biventer cervicis (figs. 2, 17) in the *Zalophus* had origin by partly tendinous slips from the postzygapophyses (or their vicinity) of the first four thoracic and last two cervical vertebrae. Insertion was upon the middorsal line for several centimeters caudad of the vertex, and for about two centimeters along the medial occipital border. In *Arctocephalus* origin is said to be from the second, third, and fourth thoracic vertebrae: In *Odobenus* "from the seventh dorsal"; in *Eumetopias* "from the fifth, second, and first dorsal spines."

M. complexus (figs. 2, 17) in the *Zalophus* arose by slips from the vicinity of the postzygapophyses of the middle five corvicals, the one to the sixth lying mediad of the cranial border of the biventer cervicis. Insertion was rather narrow in a tendinous sheet for a couple of centimeters along the occipital border laterad to the insertion of the biventer cervicis. In *Arctocephalus* and *Eumetopias* origin is said to be from the third to seventh cervicals; in *Odobenus* "from the fifth anterior dorsal."

In my *Phoca* the biventer cervicis and complexus were indivisible, forming the following:

M. semispinalis capitis (fig. 3), arising in this *Phoca* from the vicinity of the postzygapophyses of the last six cervical and first two thoracic vertebrae. It was a heavy muscle at origin, the fibers converging to a thin, aponeurotic insertion upon the medial third of the occipital crest. Miller, however, apparently had no trouble in separating this muscle in his *Phoca vitulina* into a biventer and complexus, but the attachments were very similar to those of mine.

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[4] It is believed that in the case of the wood rat (Howell, 1926) the two divisions of the biventer cervicis as stated should rather have been considered to comprise both that muscle and the complexus, while the complexus, so termed, is in reality the tracehlomastoid.

M. rectus capitis posterior major (figs. 2, 3) in the *Zalophus* arose not only from the whole length of the spine of the axis but also from the periosteum over the spine of the third cervical. Insertion was upon the supraoccipital laterad to the border of the biventer cervicis. In the *Phoca* it was larger and covered both the minor division and the inferior oblique as well. Origin was from practically the entire length of the axial spine and insertion was upon the occiput from the vertex almost to the lateral margin of the semispinalis capitis insertion. In *Arctocephalus* and *Eumetopias* origin was confined to the axis. In *Odobenus* it also "has attachments to the five posterior cervical zygapophyses."

M. rectus capitis posterior major acessorius (fig. 3), so termed by Miller and Murie for the animals which they dissected was not distinguished in the *Zalophus*, but in the *Phoca* arose from the cranial border of the axial spine, with insertion upon the occipital between the superior oblique and minor rectus.

M. rectus capitis posterior minor (figs. 2, 3) lay deep to the last. It took origin from the dorsal arch of the atlas and inserted upon the supraoccipital deep to the last. In the *Phoca* it was similar save that the insertion was situated mediad to the accessory part of the major division.

M. obliquus capitis superior (figs. 2, 3) arose from the transverse process of the atlas, with insertion strongly upon the lateral part of the occipital plane.

M. obliquus inferior in the *Zalophus* arose from the spine of the axis deep to the rectus major, with insertion upon the transverse process of the atlas. In the *Phoca* it seemed to be easily divisible into two similar parts. Miller found it single in his *Phoca*, however.

The perineal muscles were not investigated but it was noted that the levator ani, apparently occurring in two divisions, was poorly developed, or rather that the fibers were coarse and separated by much fatty tissue.

MUSCLES OF THE ANTERIOR LIMB

MUSCLES OF THE SHOULDER GIRDLE

M. supraspinatus (figs. 7, 9, 16, 19, 20, 21) was complex in the *Zalophus*, as is often the case. Origin was from the entire supraspinous fossa and anterior surface of the spine. Near the insertion it was separable into two slips, the more dorsal inserting upon the tip of the greater tuberosity with a few fibers passing also to the lesser. The second slip inserted upon the greater tuberosity also, just distad of the tip. In the *Phoca* origin was the same, and the muscle was partially divisible ectad, as indicated in Figure 21. Insertion was upon the greater tuberosity and upon the ligament extending from

the greater to the lesser. In the animals dissected by Murie and Miller this muscle was essentially the same, with minor variations.

M. infraspinatus (figs. 7, 9, 20, 21) in the *Zalophus* probably had not more than one-fifth the strength of the supraspinatus. It arose over the spinal two-thirds of the infraspinous space and converged to a slip that passed over the lateral head of the femur to insert upon a slight ridge upon the lateral base of the greater tuberosity. In the *Phoca* this muscle was even much smaller—to a surprising extent. Origin was from the deep part of the spine and about one-half of the narrow space which constituted the infraspinous part of the scapula. It passed craniad over the acromial notch and inserted upon the capsule of the shoulder joint adjoining the supraspinatus and over the greater tuberosity.

The ventral part of the cephalohumeral is homologous with a part of the deltoid. The only remaining part of the latter was the deltoid.

M. deltoideus (figs. 7, 9, 17, 20, 21). In both my specimens this was relatively very powerful and overlay almost all of the infraspinous part of the scapula. In the *Zalophus* it arose by tendinous and fleshy fibers from the entire posterior border of the spine of the scapula and by tough aponeurosis from the dorsal border of the infraspinous fossa, although muscle fibers were not found so far dorsad near the spine. Insertion was aponeurotic, chiefly along the lateral border of the deltoid ridge, but a tendinous slip also passed to the ectepicondyle of the humerus, and the distal border passed inseparably into the substance of the supinator longus. In the *Phoca* origin was only from the caudal border of the spine, with insertion partly tendinous upon the caudal border of the deltoid crest. In *Arctocephalus* no mention was made of any junction with the supinator longus, but it was stated that a "tendinous slip goes to the fibro-cellular bar lying upon the anterior border of the radius." In *Odobenus* there was no connection with the supinator longus.

M. teres minor (fig. 7) in the *Zalophus* was exceedingly thin but broad at origin, which was from the "teres major fossa," or the posterior third of the infraspinous space. It apparently fused with the subscapularis over the axillary border and the insertion was inseparable. In the *Phoca* it was as broad distad as, but much thinner than, the infraspinatus. It arose not as in *Zalophus* but aponeurotically from the distal half of the ridge between the two concavities of the infraspinous space, and was located between the latter muscle and the triceps. Near insertion the fibers joined the tendinous deep belly of the deltoid, and were inseparable. Miller stated that in *Phoca vitulina* insertion was upon the greater tuberosity and the capsule of the joint; but he did not find it in *Arctocephalus*. In *Eumetopias*

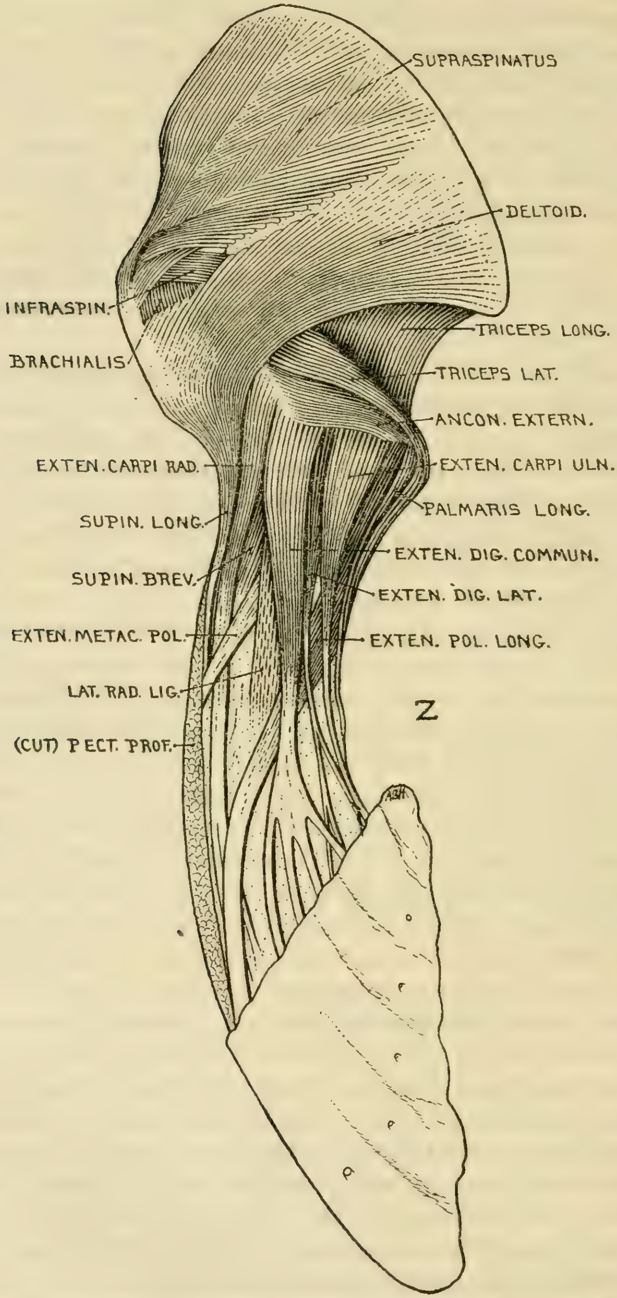

FIG. 20.—SUPERFICIAL MUSCULATURE OF THE LATERAL ASPECT OF THE LEFT ANTERIOR LIMB OF ZALOPHUS

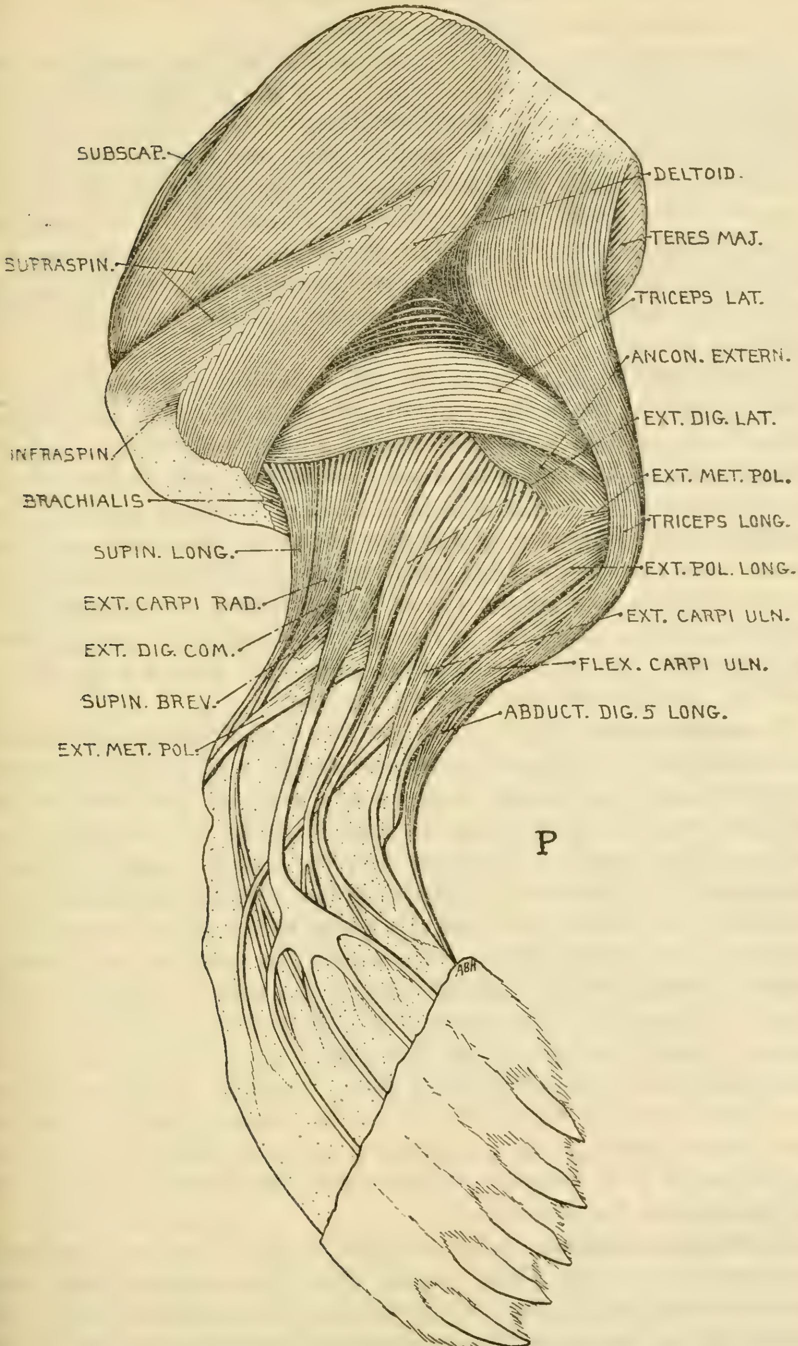

FIG. 21.—SUPERFICIAL MUSCULATURE OF THE LATERAL ASPECT OF THE LEFT ANTERIOR LIMB OF PHOCA HISPIDA

Murie reported it in close union with the teres major, and in *Odobenus* he did not succeed in segregating it.

M. teres major (figs. 7, 9, 21, 22, 23) in the *Zalophus* arose from the more dorsal part of the axillary border of the subscapularis and by fasciculi from the dorsal quarter or third of the axillary border of the bone. The insertion was broadly tendinous at about the middle of the humeral shaft and under cover of the biceps. In the *Phoca* it arose over practically the entire axillary half of the infraspinous space, including the glenovertebral cartilage. It passed between the triceps and the subscapularis to insert upon the well-defined rugosity in the bicipital groove of the humerus, slightly proximad to the middle.

M. subscapularis (figs. 9, 21, 22, 23) exhibited complexity of its fibers, as usual. In the *Zalophus* it arose from the entire medial surface of the scapula and even extended over the axillary border, while insertion was upon the lesser tuberosity deep to that of the episubscapularis. In the *Phoca* it was exceedingly massive, and overhung both the cranial and axillary borders. The latter part was partly separable, originating from the ventral border of the glenovertebral angle, and might almost be considered as constituting a separate muscle. Insertion of the whole was upon the lesser tuberosity, in this case larger and more prominent than the greater, a fact due chiefly to the power of this muscle.

M. episubscapularis (figs. 7, 22), in the nomenclature of which I follow Miller for convenience, is undoubtedly a division of the subscapularis and was folded over upon a part of the latter in the *Zalophus* only. It arose from the medial coracovertebral angle and border of the scapula and passed over the cranial edge of the subscapularis. It developed a tough tendon within the substance of the muscle which branched, one slip going to the lesser tuberosity in company with muscle fibers. The other was attached to a faintly defined groove upon the medial part of the ridge extending distad from this tuberosity and beneath the insertional end of the teres major. Upon this tendon and the adjoining dorsal border of the teres major the remaining muscle fibers inserted. This muscle has been found in all of the eared seals so far dissected, and the walrus also. Murie seems to have considered it to be a derivative of the supraspinatus in his report on *Eumetopias*, but listed it as a part of the subscapular for *Odobenus*.

M. subscapulo-capsularis (fig. 9) is found in the *Phoca* only, and was represented by a few fibers arising from the extreme distal part of the subscapular surface of the scapula, with insertion upon the capsule of the joint and the adjoining base of the lesser tuberosity. Miller stated that in *Phoca vitulina* it arose from the base of the axillary border.

MUSCLES OF THE UPPER ARM

The flexors comprise two single muscles:

M. biceps brachii (figs. 7, 10, 22, 23) was single and took origin, largely by tendon, from the rudimentary coracoid process upon the cranial margin of the glenoid cavity. In both genera it passed through the bicipital groove, between the greater and lesser tuberosities and was inserted by tendon onto the bicipital rugosity of the radius.

M. brachialis (figs. 9, 10, 20, 21, 22) was also single, with origin in the *Zalophus* from the cranial half of the proximo-lateral shaft of the humerus and from the caudo-lateral border of the deltoid ridge. A few of its fibers fused with the supinator longus. In the *Phoca* origin was from practically the whole of the lateral shaft of the humerus caudad of the deltoid ridge. In both animals the muscle passed deep between the supinator longus and pronator teres to insert by a strong tendon upon the rugosity just distad of the lesser sigmoid cavity of the ulna. Murie and Miller wrote that in *Eumetopias* and *Arctocephalus* this muscle arose by two heads, the two together being very similar to the one in my *Zalophus*.

Murie reported a very weak coraco-brachialis in *Odobenus*, but I am not at all convinced by his text that he was not mistaken in this.

In contrast to the paucity of flexors, the extensors of the brachium are powerful and specialized.

M. epitrochlearis (fig. 22) (as of Reighard and Jennings, not the dorsoepitrochlear of some authors) was found in the *Zalophus* only, but neither Murie nor Miller seem to have encountered a similar muscle during their dissections of eared seals, they, perhaps, having considered it as integral with the triceps. It has, however, all the characteristics of a normal epitrochlear as found in so many mammals, save that the great specialization of the long triceps has caused the latter to curve around partly superficial to it. It arose from the fascia and connective tissue investing the medial part of the triceps longus and latissimus dorsi. The fibers ceased in the fascia of the ulnar border of the forearm, and thus the insertion had migrated somewhat distad, as have so many other muscles of the anterior extremity.

The true triceps had best be considered as consisting of three parts as usual.

M. triceps longus (figs. 7, 10, 16, 17, 20, 21, 22, 23) in the *Zalophus* was divisible into two portions. The more caudal part arose from the dorsal third of the slight ridge that bisects (roughly) the infraspinous space of the scapula, and by an aponeurosis covering the teres major. It passed to the olecranon, twisted in a peculiar manner, and was attached rather lightly at this point. It was then ap-

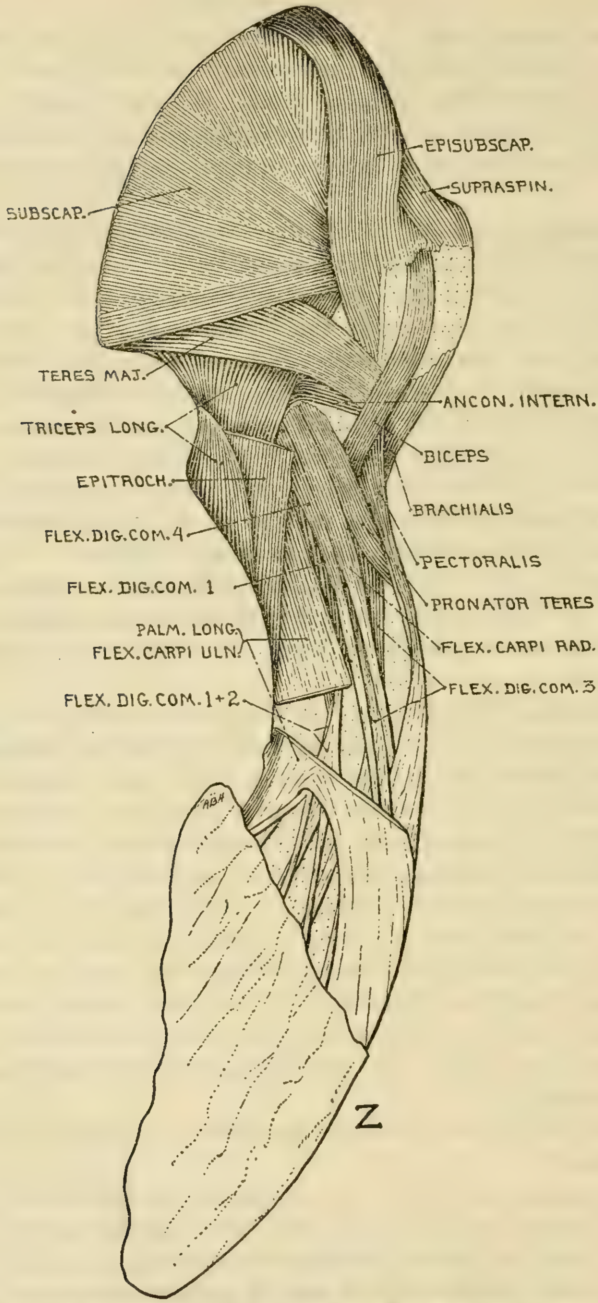

FIG. 22.—SUPERFICIAL MUSCULATURE OF THE MEDIAL ASPECT OF THE LEFT ANTERIOR LIMB OF ZALOPHUS

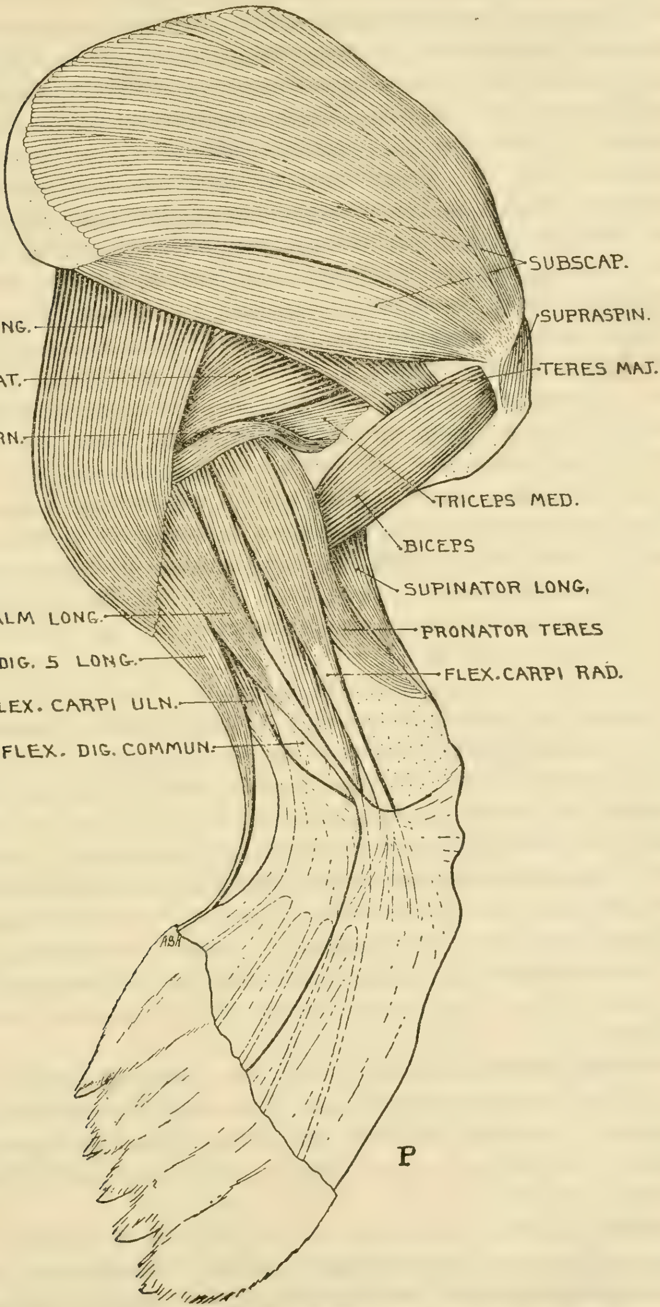

FIG. 23.—SUPERFICIAL MUSCULATURE OF THE MEDIAL ASPECT OF THE LEFT ANTERIOR LIMB OF PHOCA HISPIDA

parently inseparable from the adjoining part of the lateral triceps. It disappeared in fascia over the ulnar border of the forearm. The more cranial division did not really constitute a distinct muscle but was easily separable. It arose from the distal half of the central ridge of the infraspinous space and was strongly inserted upon the medial olecranon and (by fascia) onto the medial epicondyle of the femur. In the *Phoca* I consider this muscle to have been single. It arose from the dorsal third of the ridge upon the infraspinous space and thence the line of origin curved about the adjoining part of the vertebral border of the scapula as far as the spine, in contrast to this part of the origin in the *Zalophus* which was directed *away* from the spine. It became very thick and passed over the elbow to a rather abrupt insertion upon the superficial fascia of the forearm.

M. triceps lateralis (figs. 7, 9, 10, 17, 20, 21, 23) in the *Zalophus* arose partly from the aponeurosis covering the cranial portion of the long head, but chiefly by narrow fasciculi from the latero-caudal neck of the humerus. The borders of this muscle were distinct but the deep fibers blended with those of the medial head. With the latter there was also some fibrous attachment to the olecranon but the muscle finally passed over this and together with the adjoining part of the long head was directed down the ulnar border of the forearm and disappeared in fascia above the wrist (in fig. 20 the edge of this part of the muscle is shown trimmed away). In the *Phoca* I list this muscle as occurring in two divisions. The more lateral and the one shown in figure 21 arose from an area that really constitutes the latero-caudo-proximal border of the deltoid ridge, quite to the head of the humerus. There is considerable question in my mind as to whether the second division does not really belong with the triceps longus—a point difficult to prove by the innervation. But the origin was separated from that of the true long triceps by a considerable interval and it seems more natural to place it with the lateral division. It arose from the distal (cranial) third of the central ridge of the infraspinous space, passed down the back of the brachium and joined the first division, both inserting upon the more dorsal process of the olecranon.

M. triceps medialis (figs. 9, 10, 23) arose from the entire caudal part of the shaft of the humerus and was continuous with the anconeus externus. Insertion in both genera was upon the expanded radial aspect of the olecranon, and slightly from the caudal or dorsal aspect as well.

Miller reported that in his *Phoca* and *Arctocephalus* conditions were on the whole very similar to what I found in my seal and sea lion, respectively, save that he divided the triceps into four parts—a dorsi-epitrochlear corresponding to my first division of the long head in *Zalophus* and long head in *Phoca*. In his *Phoca* origin was from

the dorsal border of the scapula only. His long head corresponds to the lower division of the long head in *Zalophus* and upper division of the lateral head in my *Phoca*. His external head corresponds to my lateral head in *Zalophus* and lower division of the lateral head in *Phoca*. And his internal head corresponds to my medial one. Murie listed four similar divisions for *Eumetopias* and *Odobenus*. Humphry reported that in *Phoca* the long head reached the paddle, which has not been confirmed by anyone since.

M. anconeus externus (figs. 9, 10, 20, 21). It is only because Murie and Miller listed this as a muscle separate from the medial triceps that I follow the same course, for in both my specimens the two were fused. In both genera it may be said to originate from the lateral epicondyloid ridge, with insertion along the dorsal two-thirds of the external border of the olecranon.

M. anconeus internus (figs. 9, 10, 22, 23) has origin from the same situation in both *Zalophus* and *Phoca*—the entepicondylar ridge—save that in the former it was from the most prominent part of the bone, and in the latter, caudad of the entepicondylar foramen, rather than from the more prominent part craniad thereto. Insertion of both was upon the tuberosity upon the medio-dorsal part of the olecranon.

MUSCLES OF THE FOREARM

The flexors consist of the following muscles:

M. palmaris longus (figs. 10, 20, 22, 23) was of phenomenal power in the *Zalophus* and was fused with the flexor carpi ulnaris. The two together arose from the entire medial surface of the broad proximal half of the ulna, including the olecranon. Certain of the more superficial fibers decussated with those of the border of the triceps longus. It rapidly became broadly tendinous (25 mm. wide) as it passed over the wrist, was attached (the flexor ulnaris portion) to the pisiform, and then spread as in Figure 22, a powerful branch going to digit 1, and a weaker to digit 5, deep to its flexor sublimis tendon. It is perhaps the strongest flexor of the manus, working upon the two borders in an extraordinarily powerful cupping action. In the *Phoca* it was rather small and arose from the olecranon between the long abductor of the fifth digit and the internal anconeus. Its tendon expanded to cover the three medial digits and adjoining part of the carpus.

It is difficult to see why Murie and Miller both made the mistake they did in their treatment of this muscle. For *Arctocephalus*, *Eumetopias*, and *Obobenus*, the palmaris longus of Miller and primus of Murie was really a superficial division of the digitorum profundus, tentatively termed by me a flexor pollicis longus because of its position. Innervation is by the median nerve, and although this fact

was inferentially mentioned by Miller, he did not take into account that such innervation prevents affinity with the palmaris. There was intimate attachment of its tendon to the palmar fascia, indubitably, and ultimately the fusion will probably be complete, but careful dissection proves that the main portion of the tendon extends to the pollex. Miller's palmaris superficialis and Murie's secundus division were merely the antibrachial extension of the pectoralis, which also had intimate connection with the palmar fascia. I found nothing whatever in the *Phoca* that could correspond with Miller's second head of the palmaris for the same genus. His first head is very similar to the muscle as I found it.

M. pronator teres (figs. 9, 10, 22, 23) lay mediad of the biceps and brachialis. In the *Zalophus* it arose in intimate relation with the flexor carpi radialis from the proximo-caudal margin of the medial epicondyle of the humerus. In the *Phoca* it was from practically the same spot. Insertion in both was upon the radius from near the bicipital rugosity to just distad of the process or angle near the center of its radial border.

The ulnaris and radialis muscles of the Mammalia are usually rather uniform in their locations, but the digitorum muscles—especially the flexors—are annoyingly in the habit of occurring in a great number of combinations. In many cases these are of such a nature that it is unwise to place too much reliance upon the homology as indicated by the nomenclature employed, for in this case the innervation proves to be of little or no aid. Not only does origin vary, but the tendons of insertion are often unreliable as criteria for nomenclature—a muscle homologous with a pollicis may not reach the thumb, or a digiti quinti the fifth digit. The pinnipeds have these flexor muscles of such a sort, and I deem it eminently wise not to refer to the muscular divisions by name but by number, for they are not now to be homologized with any certainty.

M. flexor digitorum communis (figs. 9, 10, 22, 23) in the *Zalophus* consisted of four separable elements, while in the *Phoca* there were three which were separable only at origin.

Caput 1 (figs. 10, 22) in the *Zalophus* was a part of Murie's flexor sublimis digitorum in *Eumetopias.* It arose upon the ulna from caudo-mediad of the sigmoid cavity, passed distad directly superficial to the second division and split into three branches which went to the three lateral digits. The one to the third proved to be double, however, and there seemed to be a broadening of the tendon in the direction of digit 2, possibly indicating the relic of a former branch at this point. These three tendons were the most superficial of any going to their respective digits, the one to the fifth ultimately passing superficial even to the lateral palmaris longus branch. (See fig. 22.)

Caput 2 (figs. 9, 10, 23) in the *Zalophus* was the second part of the flexor sublimis of Murie for *Eumetopias*. It arose from the medial epicondyle of the humerus and from the medio-radial border of the ulna from just distad of the coronoid to within a short distance of the end of the shaft. Its short tendon partly fused with the deep surface of that of the first division and when dissected free it was found to go to digit 4 only. In *Eumetopias* the two heads of the flexor sublimis joined and the tendon sent branches to the four lateral digits. In this as in *Zalophus* the tendons of the first two divisions were entirely separable from those of the third division. In *Arctocephalus* this part of the flexor complex was single and there was fusion of the tendons with those of the third division.

Caput 3 (figs. 10, 22) in the *Zalophus* and Murie's flexor profundus for *Eumetopias*, arose over the medial radius between the biceps, pronator teres, interosseous membrane, and to within a short distance of the distal end of the shaft. Its tendon sent branches to the first three digits. In *Eumetopias* origin was from both the ulna and radius, and two tendons extended to the pollex, two to the index, and one to digit 3.

Caput 4 (figs. 9, 22) in the *Zalophus* was a flexor pollicis longus, innervated by a branch of the median nerve and homologically a division of the flexor profundus, though whether morphologically the same division of this muscle as its analogue in human anatomy is not known. For *Eumetopias*, with origin the same, Murie termed it palmaris longus primus, he believing that its tendon ended in the palmar fascia. Of course, such may actually have been the case in that genus, but the condition in *Zalophus* proves that it is a part of the flexor communis. Origin was from the medial epicondyle adjoining the flexor carpi radialis. Its tendon passed in the superficial flexor layer and near the base of metatarsus one it divided into two, both branches inserting upon the pollex—presumably upon its first phalanx.

In *Arctocephalus* this complex was considerably different. It arose by three heads which Miller termed as follows: A flexor sublimis, from the medial epicondyle with tendon fusing with that of the next; a flexor profundus, from the medial surface of the proximal ulna; and a flexor pollicis longus, from the medial surface of the shaft of the radius and slightly from the ulna, which joined the common tendon of the flexor profundus, and this went to all five digits. For *Odobenus* Murie reported it still different, with the sublimis and profundus bellies partially fused, and a flexor pollicis radiad. All of these were conjoined to a broad tendinous sheet with five branches to the digits. The three divisions named are analogous

to those of man, but there seems to be some doubt as to whether they are homologous.

In the *Phoca* the flexor digitorum communis arose by three heads. *Caput a* had origin from the medial epicondyle below the flexor carpi radialis; *caput b* had origin from the whole of the medial surface of the olecranon and from two-thirds of the shaft of the ulna; while *caput c* originated from the radius, upon the ulnar side of the pronator teres insertion. The three heads joined to form a very broad tendinous band which split into five branches, one going to each digit. This was substantially the same as conditions in the *Phoca vitulina* of Miller, who called caput *a* the flexor sublimis, caput *b* the flexor profundus, and caput *c* a flexor pollicis longus. His nomenclature may possibly be correct and the divisions seem to be homologous with those of *Arctocephalus*, but they certainly are not with those bearing the same terms for *Eumetopias*, as designated by Murie.

M. flexor carpi radialis (figs. 9, 22, 23) lay upon the ulnar side of the pronator teres. It arose in both animals from the medial epicondyle. In the *Zalophus* its tendon inserted chiefly upon metacarpus one deep to that of the supinator longus, but a tenuous branch went also to metacarpus 2. In the *Phoca* insertion was also upon metacarpus 1 and 2, and probably 3 as well. Miller reported three branches to the three metacarpals in *Phoca* and three in *Arctocephalus* to the first two metacarpals and the ligament between the trapezium and trapezoid. In *Eumetopias* insertion was upon the first metacarpal only.

M. pronator quadratus (fig. 9). Murie found this muscle in *Odobenus* but not in *Eumetopias*, while Miller did not find it at all in *Phoca* or *Arctocephalus*. In the *Zalophus* it was represented by a few fibers upon the flexor side of the interosseous membrane, while in the *Phoca* it was weakly though indubitably present.

M. flexor carpi ulnaris (figs. 10, 21, 22, 23) in the *Zalophus* was fused with the palmaris longus. It was the ulnaris portion of the latter muscle, however, that was attached to the pisiform. In the *Phoca* it was located between and deep to the palmaris and long abductor of digit 5, and was a robust muscle. Origin was from the medial olecranol border, with a rather complex insertion, for although there was attachment to the pisiform as usual, the main thread of the tendon continued to metacarpus 5. In addition a tendinous fascia was given off mediad, this forming a second and deeper palmar fascia, and this curved deep and laterad to form part of the thick sheath of the flexor digitorum communis. In *Arctocephalus* and *Eumetopias* it was very similar to that of *Zalophus*. In his *Phoca* Miller reported the same condition found by me in the same genus, save that he made

no mention of complexity in connection with the sheath of the flexor communis.

M. abductor digiti quinti longus (figs. 10, 21, 23) was really a flexor and was served by the ulnar nerve. Its homology is not certain but it seems probable that it may be a division of the flexor carpi ulnaris. It was present in *Phoca* only and arose by aponeurosis from the ulnar termination of the olecranon and its tendon inserted upon the first phalanx of digit 5.

In the *Zalophus* the antibrachial extension of the pectoralis must be included with the flexors of the lower arm. In the juvenal specimen this detail proved puzzling, for after the part of the pectoral aponeurosis inserting upon the deltoid ridge had been removed and the subdermal tissue of the manus dissected free, there remained an apparently distinct structure wth muscle fibers attached arising from the slight ridge extending from the deltoid crest to the medial rim of the trochlea. This emerged from between the biceps and the brachialis, and then fused with an extensive and touch sheet of fatty fibrous tissue covering the radial border of the forearm and metacarpus 1. With this were associated dark fibers apparently muscular in character. In Figure 19 this detail is shown as encountered in this specimen after removal of the part of the pectoral inserting upon the deltoid crest, except that the fibrous tissue extending farther upon the cranio-lateral part of the forearm is represented as having been cut away. In a fresh, adult female, however, it was at once seen that this was a part of the deep pectoral, which, in a tendinous sheet, inserted upon the humerus for the entire length of its shaft, extending quite to the pollex, and with it was associated a thick, fatty, fibrous layer, entirely nonmuscular in this adult, that was most extensive over the anterior or radial border of the arm and acted not only as a buffer or shock absorber, but materially broadened the forearm. The fleshy part of the pectoralis that covered the proximal part of the medial forearm was erroneously designated as a superficial layer of the palmaris longus by Murie for *Eumetopias*, and by Miller for *Arctocephalus*.

The extensors of the antibrachium were as follows:

M. extensor digitorum communis (figs. 9, 10, 20, 21) was the most superficial of the forearm extensors, and arose in a thin sheet from the lateral epicondyle of the humerus. Its tendon passed beneath the dorsal carpal ligament close to that of the extensor pollicis longus and in both animals a branch was sent to each of the four lateral digits. This is Miller's primus division of this muscle in his *Phoca*. In *Arctocephalus* he stated that it split into two slips, one being the same as I found the extensor communis in *Zalophus* and the second constituting an extensor minimi digiti. In *Eumetopias* and

Odobenus the slip representing this muscle split into three tendons passing to the three middle digits.

M. extensor digitorum lateralis (figs. 9, 10, 20, 21) is, in most mammals, a more fitting name for this muscle than its homologue, extensor digiti quinti proprius. In the *Zalophus* it was located between and partly deep to those of the extensores communis and carpi ulnaris. It arose from the distal part of the lateral epicondyle and the lateral radial ligament in such a position that tension could be applied only during flexion of the forearm. It was a weak and slender muscle whose fine tendon split first into two, the lateral branch going to the lateral border of the fifth metacarpal. The medial branch again divided into two, sending one tendon to the medial side of metacarpus 5 and another to the adjoining border of the fourth. In the *Phoca* this muscle was quite complex and occurred in three parts which were not completely divisible proximad. Origin was considered to be from the lateral epicondyle only, although there was quite firm attachment to the capsule of the joint over the head of the radius. Three tendons developed from as many muscular slips which passed ectad of the long extensor of the pollex. The more ulnar of these split into two branches which extended to metacarpals 4 and 5. The more radial also split into two, extending to metacarpals 2 and 3, while the deeper (not shown in fig. 21) inserted upon the ulnare. For this muscle in *Eumetopias* Murie recognized two divisions, equal together to my one. One was a minimi digiti, with tendons to digits 4 and 5, and the other a medii digiti, with tendons to digits 3 and 5. In *Obodenus* these tendons went only to digits 4 and 5. Miller considered that for *Arctocephalus* there was a single head of origin for the communis digitorum and minimi digiti. The latter divided into three main branches going to metacarpals 4 and 5. For *Phoca*, Miller termed this division the extensor communis secundus, mentioning no divisions of the muscle itself but that it split into four tendons, passing to the four lateral metacarpals.

The structure referred to above as the lateral radial ligament deserves mention. It occurred in the *Zalophus* only, as a broad, tough band extending from the lateral epicondyle over the lateral aspect of the radius to somewhat distad of its middle. It covered the supinator brevis and was continuous along its border with the interosseous membrane where this adjoined. Its function was as its name implies—to add great strength to the joint. It was not an outgrowth of the normal capsular ligament of the elbow, for it not only had some vestige of muscle fibers associated with it but seemed to be served by the dorsal interosseous nerve, which indicated that it may have been a relic of some primitive division of the common extensor group of the digits. No mention was made of such a structure in other eared seals.

M. extensor metacarpi pollicis (figs. 10, 20, 21) arose in the *Zalophus* from the whole of the fossa of the lateral ulna that was situated upon the radial side of its prominent lateral ridge, and extended in origin two thirds the length of the shaft. It ran obliquely across the radius and its tendon passed through the large groove upon the cranio-lateral termination of the radius. It then passed to a double insertion, the first to the medial base of metacarpus 1, and the other to the first phalanx of the same digit. In the *Phoca* it arose from the whole of the lateral face of the olecranol plate save the extreme ulnar tip. Its tendon inserted as normal upon the base of metacarpus 1. This was termed extensor ossi metacarpi pollicis by Murie and Miller. From the former's description, insertion in *Eumetopias* and *Odobenus* seems to have resembled that in my *Phoca*, but the tendon was much weaker in the latter animal.

M. extensor pollicis longus (figs. 10, 20, 21) in the *Zalophus* arose from that part of the fossa on the lateral ulna that was situated upon the ulnar side of its prominent ridge. Its very broad tendon extended obliquely across the carpus and was inserted upon the dorsum of the first phalanx of the pollex. In the *Phoca* it arose from the ulnar tip of the lateral olecranon and for some little distance distad, while insertion was as in *Zalophus*. For *Eumetopias* Murie termed this muscle extensor pollicis et indicis but noted no differences, and it is Miller's extensor primi internodii pollicis. In the latter's *Phoca vitulina* origin was from the posterior third of the ulna.

M. extensor carpi ulnaris (figs. 9, 10, 20, 21) in the *Zalophus* appeared very similar in its proximal portion to the extensor communis. It arose by aponeurosis from the radial two-thirds of the olecranol border of the ulna beneath the lateral anconeus. Its rather slender tendon passed to the lateral manus and was inserted upon the lateral border of metatarsus 5. In the *Phoca* origin was from the lateral epicondyle of the humerus, while insertion was normal as in *Zalophus*.

M. extensor carpi radialis (figs. 9, 10, 20, 21) was single in its muscular portion and arose from just dorsad of the lateral epicondyle proper. It extended next laterad to the supinator longus and its tendon was seen to be double. In the *Zalophus* these are doubly inserted into the lateral border of metacarpus 1 and the medial border of metacarpus 2. In the *Phoca* one tendon went to metacarpus 2 and the other sent two branches to metacarpals 2 and 3 respectively. As this insertion was different from anything reported for the genus, I was careful to verify it. Miller wrote that in *Phoca vitulina* insertion was upon the first and second metacarpals, while in *P. barbata* it was upon the second only.

M. supinator longus (figs. 9, 10, 20, 21, 23) in the *Zalophus* was specialized. Origin was from the more caudal portion of the lateral shaft of the humerus extending quite to the head and partially between the brachialis and triceps. This excepts the deltoid crest, from the distal termination of which arose but a few fasciculi of this muscle. It then passed between the brachialis and extensor carpi radialis and was joined by the more distal part of the deltoid. Its tendon was inserted upon the most prominent part of the radial aspect of the distal termination of the radius, just deep to the tendon of the extensor metacarpi pollicis. In the *Phoca* origin was much more restricted and more caudad, and there was no connection with the deltoid. Murie stated that in *Eumetopias* this muscle had two heads, the second from the deltoid crest, but I judge that there was little difference from conditions in the *Zalophus*. From the description of *Arctocephalus* the origin in this animal was more extensive.

M. supinator brevis (figs. 9, 10, 20, 21) had its usual complex origin, chiefly from the capsule of the elbow joint, but also upon the lateral condyle of the humerus as indicated. (Fig. 9.) Insertion in both animals was upon the cranio-lateral part of the radius from its head to the pronator teres angle.

The short muscles of the manus of these two families of pinnipeds were adequately investigated by Murie and Miller, and as they are not particularly pertinent to the present report, they are here omitted.

MUSCLES OF THE POSTERIOR LIMB

MUSCLES OF THE HIP

The hypaxial muscles or psoal complex presented no especial difficulties in *Zalophus*, but in the *Phoca* they were extremely closely associated, peculiar, and withal so tender that nice dissection was entirely out of the question. Miller found these muscles different in each phocid which he dissected, his descriptions are too involved, and at least one error is indicated, for his magnus did not go to the limb. His contribution is therefore of slight aid in this respect, nor am I able to homologize things entirely to my own satisfaction.

M. psoas minor (figs. 11, 24) in the *Zalophus* was rather small and arose apparently from all the lumbar vertebrae, but craniad the association with the quadratus lumborum was so close that one can not distinguish between the two muscles with certainty. A very slender separate head also arose from the centrum of the last lumbar, joining the remainder by a small tendon. The whole became stoutly tendinous and inserted upon the pectineo-psoal process of the innominate. In the *Phoca* the part that indubitably represented this muscle was

the most medial of the divisions and also small. It arose apparently from the last three lumbars and inserted slenderly upon the pectineal process. Conditions have been essentially similar in the other pinnipeds dissected, including a small *Phoca vitulina* by Miller; but in the case of a large specimen of this species the same author stated that this muscle was enormous and much larger than the psoas major, which seems to indicate that an error was made in either one or the other.

M. psoas magnus (figs. 11, 12, 13, 24) in the *Zalophus* was less robust at the original but larger at the insertional end than the minor

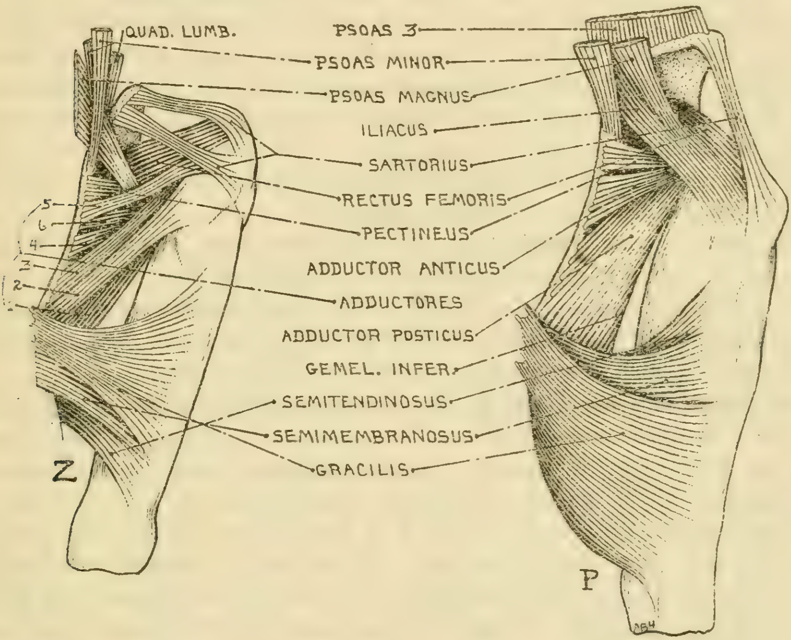

FIG. 24.—VENTRAL ASPECT OF THE MUSCLES EXTENDING FROM THE INNOMINATE BONE (STIPPLED) TO THE POSTERIOR LIMB OF ZALOPHUS (*Z*) AND PHOCA HISPIDA (*P*)

division. Origin was from the last two lumbars and the extreme anterior sacrum. It passed beneath (dorsad of) the minor and between the rectus femoris and pectineus, and inserted tendinously upon the lesser trochanter. It is difficult to understand the conditions in Miller's *Arctocephalus*, or in his other pinnipeds for that matter. In my *Phoca* there was no difficulty about the insertion which was with the iliacus upon the medial tuberosity of the tibia. In this tender specimen, however, origin was entirely inseparable from a great mass of muscle extending from the thorax to insert chiefly upon the ventral part of the medio-cranial face of the ilium. About any such insertion in his specimens Miller mentions nothing.

A small slip also separated from this mass to insert upon the psoas process of the ventral ilium. The homology of this large mass of muscle is very uncertain, but it may provisionally be termed psoas tertius. (Figs. 11, 24.)

Murie considered that in *Eumetopias* either the two psoas muscles had fused or the true psoas minor was absent, the two muscles of this group therefore consisting of a psoas and an iliacus. For *Odobenus* he said that the two psoas were closely united, and inserted by a common tendon upon the ilio-pectineal eminence—an interpretation that is open to question.

M. iliacus (figs. 11, 12, 13, 24) was not entirely distinct. In the *Zalophus* it was very small, arising from the ventral border of the ilium in intimate relation with the final slip of the quadratus lumborum. It inserted with the psoas magnus upon the lesser trochanter. In the *Phoca* its fibers were inseparable from the part of the psoas tertius which joined the ventral ilium, while insertion was with the psoas magnus upon the medial tuberosity of the tibia. This muscle seems invariably to be present in pinnipeds.

M. tensor fasciae femoris (figs. 12, 17) arose from the lumbodorsal fascia, in the *Zalophus* reaching the middorsal line over the last two lumbar vertebrae. In the *Phoca* the exact bounds of the muscle could not be so well defined because of the condition of the specimen. Insertion in both was upon the lateral part of the patella.

M. gluteus maximus (figs. 12, 16, 17) in the *Zalophus* had origin continuous craniad with the biceps femoris over the spines of the three sacral vertebrae. It passed over the proximal part of the greater trochanter, to be inserted upon the disto-lateral part of the same, but not appreciably onto the shaft of the femur. In the *Phoca* this muscle was very heavy, indeed, and arose by aponeurotic fascia over the middorsal space included between all four sacral and first two caudal vertebrae. It quickly converged to a tendinous insertion along the entire lateral border of the shaft of the femur from the lateral condyle to the distal part of the greater trochanter, although over the middle of this space there seemed to be no actual attachment to the bone. In both *Eumetopias* and *Arctocephalus* two heads were reported, but the separation seems to have been incomplete. At any rate, insertion was upon the shaft of the femur as well as the greater trochanter, thus resembling the condition in my *Phoca* rather than the *Zalophus*. Miller wrote that in *Phoca vitulina* there were also two heads and that one of them arose from the ilium.

M. gluteus medius (figs. 11, 12, 16, 17) in the *Zalophus* arose from the anterior border of the ilium, and this part was not covered by the gluteus maximus. Near the insertion it was separable, except at its ventral border, into two thin sheets, these forming a V-shaped tendinous attachment to the greater trochanter. In the *Phoca* this

muscle and the pyriformis of the present specimen were inseparable, the two parts being distinguished only by a faint line presumably between them ectomediad. Origin of the two together was from all but the ventral part of the "lateral" surface of the ilium practically to the acetabular border and thence upon the sacrum over the second sacral vertebrae, and upon the ridge extending to the transverse plate of the third sacral. Insertion was almost entirely fleshy upon the flattened part of the greater trochanter. In *Eumetopias* Murie reported origin as also from the sacrum, presumably the spines.

M. gluteus minimus (figs. 11, 12, 16) in the *Zalophus* seemed to be partially divisible, along its dorsal border only, into three slips. It arose from the lateral surface of the cranial half of the ilium and from two-thirds of the vertebral border, with a few fibers from the ventral surface of the ilio-sacral ligament. Insertion was strongly upon the greater trochanter. In the *Phoca* this muscle was entirely covered by the medius. It arose from the ventral fossa and ridge adjoining the "lateral" surface of the ilium. Insertion was somewhat tendinous upon the dorso-medial part of the greater trochanter.

M. gluteus quartus (figs. 11, 12). No slip representing this muscle was mentioned by either Murie or Miller. In my *Zalophus*, however, it could not be ignored. It was very slender and arose from the ilium craniad of the femoral process and with attachment also to the tendon of the rectus. It passed just superficial to the latter muscle to insert upon the greater trochanter in the angle between the insertions of the glutei medius and minimus.

M. pyriformis (figs. 12, 16) in the *Zalophus* was easily separable from the gluteus minimus, caudad of which it lay. It arose from the last two sacral vertebrae beneath the caudal portion of the ilio-sacral ligament, and converged to a tendinous insertion upon the greater trochanter. In the *Phoca*, as mentioned, this muscle was inseparable from the gluteus medius. In *Phoca vitulina* Miller separated it with care.

After disposing of the gluteal-pyriformis mass, the complex consisting of the gemelli, obturator internus and adductor posticus appeared in the seal as consisting of a single, strong, well-rounded muscle and much care was necessary in its dissection, partly, of course, because of the extreme tenderness of the fibers.

M. gemellus superior (figs. 11, 12) lay next caudad to the pyriformis. In the *Zalophus* it was a much weaker muscle, arising from the superior border of the ischium just caudad of the acetabulum. Insertion was upon the caudal aspect of the greater trochanter dorsad of the obturator fossa. In the *Phoca* origin was relatively farther caudad, and its tendon joined the other which, in turn, joined that of the obturator internus inserting into the trochanteric fossa of the

femur. Murie stated that in *Eumetopias* origin was from the sacral vertebrae, which seems unlikely.

M. obturator internus (figs. 12, 16) arose from the inner border of the obturator foramen and its membrane, passed over the dorsal border of the ischium between and in close association with the two gemelli, and inserted by the usual tendon into the trochanteric fossa of the femur.

M. gemellus inferior (figs. 11, 12, 16, 24) in both animals arose from a similar area upon the dorsal border of the ischium—roughly the second quarter of the distance from the acetabulum to the caudal border. In the *Phoca*, however, there was in addition a strong tendon arising from the bicipital process and disappearing in the substance of the muscle. In the *Zalophus* insertion was upon the side of the greater trochanter, between the obturator internus and quadratus femoris. At first glance it seemed to be a part of the latter muscle. In the *Phoca* its tendon joined the insertion of the obturator internus. For *Eumetopias* insertion was given as between the greater and lesser trochanters. Miller referred to this muscle in parts of his text but did not describe it.

M. quadratus femoris (figs. 11, 12, 16) in the *Zalophus* arose from the dorsal half of the caudal border of the ischium, bounded dorsad by the gemellus inferior, ventrad chiefly by adductor 1, and mediad by the obturator externus. Insertion was along the entire latero-caudal border of the femur. In *Arctocephalus* insertion was said to be upon the "lower half of the posterior border of the great trochanter." For *Eumetopias* Murie gave insertion as the outer side of the lesser trochanter. The muscle is absent in the Phocidae.

M. obturator externus (figs. 11, 12) in the *Zalophus* arose not just from the border of its foramen, but from a considerable area of bone caudad and ventrad, and from all but the dorsal part of the obturator membrane. Insertion was tendinous near the disto-caudal part of the greater trochanter. In the *Phoca* origin was much more restricted. It arose from the obturator membrane only over its dorsal and cranial parts, from the bone anterior to the obturator foramen, and from the dorso-cranial part of the pubis, the latter part of the muscle having almost the appearance of a separate slip. Insertion was partially tendinous into the obturator fossa of the femur. In *Eumetopias* insertion was said by Murie to be onto the lesser trochanter, while in *Mirounga* insertion was upon the greater trochanter; but in this Miller was probably mistaken, as he was, at least for *P. hispida*, when he stated that the adductors are absent in the Phocinae, for the adductors constitute the ectal part of his obturator externus, and he evidently missed the deeper and very small latter muscle.

MUSCLES OF THE THIGH

There was evident a decided tendency toward fusion of the gracilis, semimembranosus, and semitendinosus of *Phoca*, and the three together formed a great muscle mass with a single prime function. No such tendency was found in *Zalophus*.

M. semimembranosus (figs. 11, 13, 24) of *Zalophus* occurred in two parts. The posterior (really the inferior) arose from the caudal border of the ischium adjoining the symphysis and the origin of the gracilis. Insertion was narrow and fascial beneath the caudal border of the gracilis. The anterior division, of about the same size, arose from the caudal border of the ischium dorsad of the origin of the posterior part. Fascial insertion upon the cranial border of the tibia was entad of the cranio-dorsal border of the gracilis and was entirely hidden by the latter. In the *Phoca* this muscle was single and arose along the caudal border of the ischium, the more caudal part being incompletely separable from the gracilis, under cover of which muscle it extended to a fleshy insertion not directly upon the tibia but upon the heavy aponeurosis investing the ventral belly of the semitendinosus. For both *Eumetopias* and *Odobenus* Murie called this muscle semitendinosus. In *Arctocephalus* it was single, while Miller reported it double for *Phoca*.

M. semitendinosus (figs. 11, 13, 16, 17, 24) in the *Zalophus* arose from over the spines of the third to sixth or seventh caudal vertebrae, with fascial insertion upon the distal quarter of the shaft of the tibia (not including the malleolus). In the *Phoca* it occurred in two parts which were entirely distinct at origin but apparently fused more distad. The posterior division was the more superficial and much the larger. It arose robustly from the transverse processes of the first three caudal vertebrae. The anterior division arose by tendinous fascia from the caudal border of the ischium along an area adjacent to the semimembranosus but not reaching the dorsal spine. The insertional end of both parts together developed a stout aponeurosis attached along the cranial border of the tibia and the hamstring tendon. This is the muscle which Murie termed semimembranosus. It was single also in *Odobenus*, *Eumetopias*, and *Arctocephalus*.

In both animals the aponeurosis of insertion of these hamstring muscles ended in the tough fascia and connective tissue over the heel. In *Phoca* especially it may be said to end in a sort of ligament which extended from the head of the fibula to the most prominent part of the external malleolus, and there was also substantial anchorage in the fibrous tissue beneath the calcaneal tendon.

M. biceps femoris (figs. 11, 12, 13, 16, 17) in the *Zalophus* occurred in three main parts. The more superficial portion of the long head was

indeed a very remarkable muscle, origin extending from the spine of the second to that of the seventh caudal vertebrae. The fibers extended caudo-laterad to a tough sheet of aponeurosis covering the side of the lower leg and stretching from the outer condyle of the femur, the adjoining part of the tibia, and to the distal extremity of the shank. In *Eumetopias* and *Odobenus* origin was a trifle farther caudad. A posterior head was very narrow and arose under the caudal border of the main muscle, but its insertion was merely a distal continuation of that of the main mass. This may be the muscle termed by Murie a levator ani. The socalled short head of the biceps was but a couple of centimeters in width and arose partly from the transverse process of the second sacral vertebra and partly from the sacro-iliac ligament. It inserted upon the aponeurotic sheet investing the dorsal border of the distal fibula.

In the *Phoca* the biceps occurred in two divisions. The superficial arose by a strong, tendinous origin from the dorsal spine of the ischium. It spread fanwise to a fascial insertion over the proximal seven-eighths of the lateral part of the tibia. It is thus seen that in the *Zalophus* this muscle was in the form of a parallelogram, closely binding the shank to the vertebral column, while in the *Phoca* it was in the form of a triangle with pivotal apex upon the ischium, theoretically permitting much more freedom of movement. The deep division of the biceps of the *Phoca* was narrow and strap-shaped, with fleshy origin from the transverse plate of the third sacral vertebra, and aponeurotic insertion over the distal fibula. This corresponds with the short head of *Zalophus*.

Murie termed the short head in *Eumetopias* the sacro-peroneus, and Lucae designated the heads as ischio-tibialis and sacro-fibularis. In *Arctocephalus* there were three divisions, much as in *Zalophus*.

M. sartorius (figs. 11, 12, 13, 16, 17, 24) in the *Zalophus* occurred in two distinct slips. The proper one was very slender, arising from the ventral angle of the iliac border with insertion upon the medial patella partly deep to the tensor fasciae. The second arose from the cranial part of the ventral border of the ilium and had fascial insertion upon the medial tuberosity of the tibia mediad to and continuous with that of the first division. In the *Phoca* it was single, arising from the ventral angle of the ilium with insertion upon the patella continuous with and mediad to the insertion of the tensor fasciae. Miller reported it as single in *Phoca* and double in *Arctocephalus*, and Murie found it single in *Eumetopias* and *Odobenus*.

M. rectus femoris (figs. 11, 12, 16, 17, 24, 25, 26) was a robust muscle arising from the femoral process of the ilium cranio-ventrad of the acetabulum, which is prominent in *Zalophus* but indicated only by a roughened area in the *Phoca*. Insertion was upon the patella deep to the sartorius and tensor fasciae femoris.

The vasti were separable into two divisions only.

M. vastus lateralis (figs. 12, 25, 26) arose from the dorso-cranial part of the greater trochanter and for a very short distance distad along the lateral border. Insertion was upon the lateral patella and slightly upon the capsule of the joint. Miller considered that the vastus externus of all the pinnipeds which he dissected arose from the entire lateral border of the femur, and Murie from the "anterior surface of the femur," but I deem the true origin to be more restricted.

M. vastus profundus (figs. 12, 25, 26) evidently comprised a fused vasti femoris and medius. In the *Zalophus* origin was from practically the entire cranial surface of the femur, and in the *Phoca*, from only the proximal half. Insertion in both was upon the medial patella and adjoining part of the capsule of the knee partly deep to the insertion of the rectus femoris. Miller designated the deeper vastus as the crureus, and Murie, the vastus internus.

The adductors consisted of the following muscles:

M. pectineus (figs. 11, 12, 24) in the *Zalophus* arose from the dorso-caudal slope of the pectineo-psoas process of the innominate and the tendon of the psoas minor adjoining. Insertion was upon the distal border of the lesser trochanter adjoining that of adductor 6. In the *Phoca* origin was longer, from the border of the publis for a short distance directly caudad of the "pectineo-psoas process." Insertion was also fleshy upon the proximo-medial portion of the caudal aspect of the femoral shaft, or close to the corresponding position of the lesser trochanter of *Zalophus*, absent in the *Phoca*. In *Arctocephalus* origin was much as I found it in *Phoca*. Miller considered that this muscle was Murie's adductor brevis primus, and that there was really a second division, termed pectineus for *Eumetopias* and *Odobenus*, and called by Miller for *Arctocephalus* pectineo-superficialis vel femoralis. Both Murie's and Miller's treatment of the pectineo-adductor complex is irrational. There is no good reason, morphologically, for considering that the pectineus has taken upon itself complexity. The pectineus of Murie and the pectineo-superficialis vel femoralis of Miller were, in fact, clearly a subdivision of the true adductor mass.

M. gracilis (figs. 11, 13, 24) in both animals was incompletely double at origin, the two heads being separated, craniad only, by the rectus abdominis. The more ectal arose midventrad, its fibers decussating with those of its antimere, and the more entad from the symphysis and the ischium laterad thereto. Insertion was fascial, in the *Zalophus* along the middle third, and in the *Phoca* the distal half, of the tibia. In the latter animal there seemed to be a slender tendon or ligament developing from this fascia and passing over the medial malleolus and joining the plantar fascia. In *Odobenus* insertion was upon almost the entire shaft of the tibia.

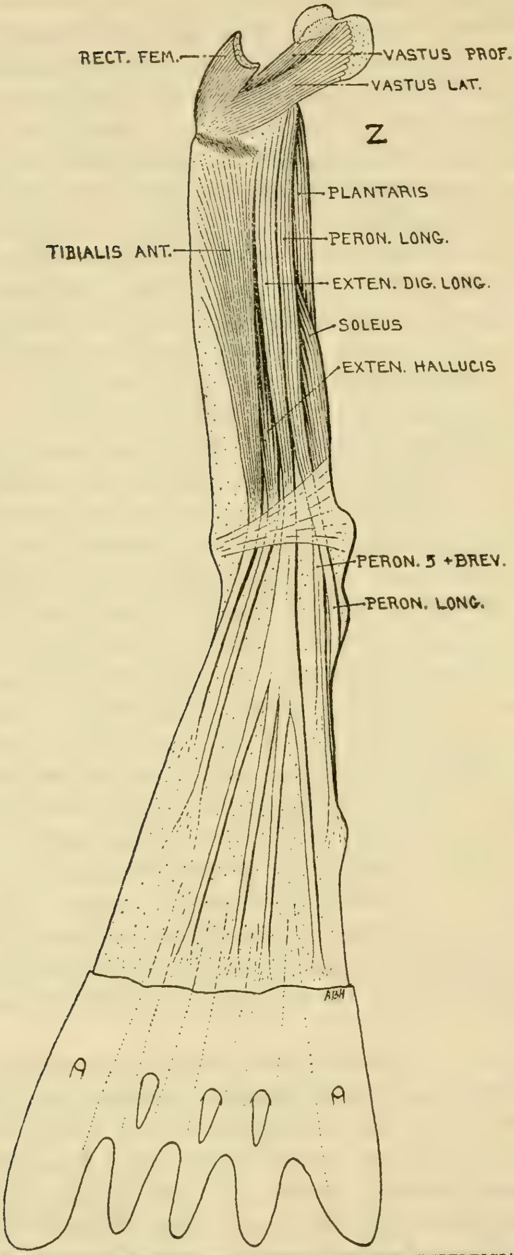

FIG. 25.—CRANIO-LATERAL ASPECT OF THE SUPERFICIAL MUSCLES OF THE LEFT POSTERIOR LIMB OF ZALOPHUS

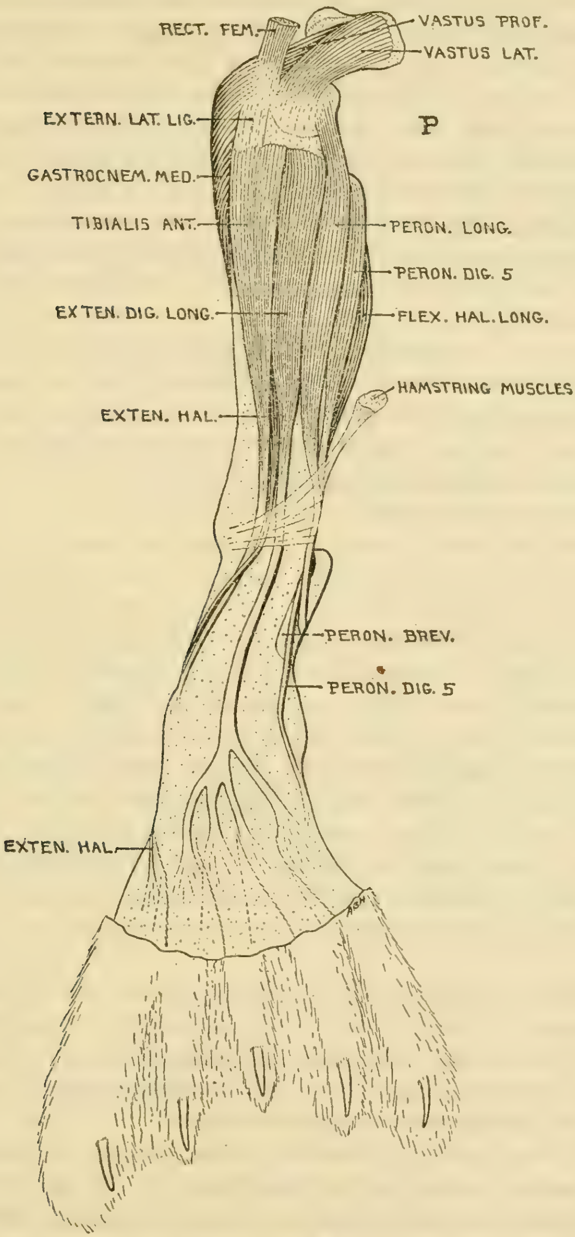

FIG. 26.—CRANIO-LATERAL ASPECT OF THE SUPERFICIAL MUSCLES OF THE LEFT POSTERIOR LIMB OF PHOCA HISPIDA

In no respect, perhaps, does the tendency for subdivision of the muscles of the posterior limb of *Zalophus* and fusion of those of *Phoca* appear more pronounced than in the adductor muscles and certain others near them. The adductors, however, when these show complexity, is one of the groups which it is as yet not only unwise but actually misleading to attempt to homologize too precisely with the human divisions, and we must know far more regarding the lower Mammalia than we now do before such a course can be taken with confidence. The reason for this is that save for a part of the adductor magnus, little can be proved by the innervation, and it is both simpler and more satisfactory to refer to a number of divisions by number. In *Zalophus* I began at the most caudaul division and worked craniad. (Figs. 11, 12, 13, 24.)

Adductor 1 in the *Zalophus* was thin and arose from the caudal border of the ischium between the origins of the semimembranosus anticus and quadratus femoris. It passed laterad to all the other adductors to a fascial insertion over the medial tuberosity of the tibia and onto a slight ridge extending along the distal border of the medial condyle of the femur.

Adductores 2 et 3 were apparently indivisible at origin, which was along the caudal half of the pubis laterad of the symphysis and that part of the ischial border that lay ventrad of the obturator foramen. These two divisions were undoubtedly homologous with at least a part of the true adductor magnus, for the femoral artery passed between their insertional parts. At the middle of the muscle the more ventral fibers separated into a ribbonlike slip—adductor 2—extending to a ridge upon the medial condyle of the femur. The deeper part, constituting adductor 3, inserted upon a long, narrow area stretching over the caudal surface of the femur from the distomedial greater trochanter to a point upon the medial border of the shaft midway between the lesser trochanter and the condyle. On the bone this is indicated by a barely perceptible ridge, corresponding to the usual linea aspera.

Adductor 4 was small and arose from the pubic border just craniad of the origin of divisions 2 and 3. It passed deep (mediad) to both of the last, broadened somewhat and inserted upon a slight ridge extending over the caudal shaft of the femur from distad of the middle of the greater to the lesser trochanter.

Adductor 5 was also very narrow, arising along the pubic border from the pectineo-psoas process to adductor 4. It passed superficial (mediad) to all the other adductors in this area to a fascial insertion over the medial epicondyle of the femur. This is the pectineus of Murie.

Adductor 6 arose from the pubis immediately deep to division 5, and inserted narrowly upon the disto-lateral border of the lesser trochanter.

The much simpler adductors of *Phoca* may be termed as follows:

Adductor anticus (figs. 11, 12, 24) was a small muscle next caudad to the pectineus and of about the same size. Origin was from the border of the pubis and insertion was mediad to that of the pectineus upon the shaft of the femur, but there was no appreciable osteological indication of the fact.

Adductor posticus (figs. 11, 12, 17, 24) was a very broad sheet of muscle arising from the caudal half of the pubic border and over the lateral surface of all of the ischium save the more caudal portion. It converged to an insertion that was largely tendinous upon the prominence upon the femur just laterad of the trochanteric fossa.

Murie indicated that there were six adductors in *Eumetopias*. As already mentioned, his adductor brevis primus is the true pectineus, and what he termed pectineus is my adductor 5. I am unable to determine the exact number of adductor divisions in *Arctocephalus* but judge that conditions were very similar to those in my *Zalophus*. Miller wrote that the adductors are absent in *Phoca*, but it is evident that he mistook the two adductors for the obturator externus and did not dissect deeply enough to encounter the latter muscle, restricted as it is in this genus.

MUSCLES OF THE LEG

M. gastrocnemius (figs. 12, 26, 27, 28) was single in the *Zalophus* and arose from the well-defined ridge upon the medial epicondyle of the femur and the capsule of the joint. It crossed to the outer side of the shank and developed a tendon (first upon its medial border) which was inserted upon the calcaneum. In the *Phoca* this muscle was double. The *medialis* was very heavy, with fleshy origin from the caudal surface of the well developed medial epicondyle. An internal tendon developed upon which the fibers from both bellies of the muscle inserted. The tendon narrowed and was attached to the calcaneum. The *lateralis* was not one-tenth the size of the medial division. It arose by a slender tendon from the lateral epicondyle of the femur, and joined the tendon of the medial division distad of the muscular part.

M. plantaris (figs. 12, 25, 27, 28) in the *Zalophus* was about one-third the size of the gastrocnemius. It arose from the lateral epicondyle of the femur in very intimate relation with, and between, the popliteus and peroneus longus. It passed deep to the tendon of the gastrocnemius, over the groove upon the medial calcaneum, and thence to the plantar fascia. With care two layers of this were dissected free. The more superficial divided into four tendons between the five digits, and each of these again divided, the branches running to the borders of the adjoining digits. The deeper layer also separated into four branches, these constituting sheaths for the flexor

longus tendons extending to the four lateral digits. These last entered the sheaths from their deep sides near the metatarsal-phalangeal joints. In the *Phoca* the plantaris was much larger than the lateral, but smaller than the medial, gastrocnemius. It had an extensive fleshy origin from the caudal surface of the lateral epicondyle, the head being really separable into two parts, one arising from the ridge at this point and the other from the slight furrow adjoining. Its slender tendon passed mediad from beneath the gastrocnemius and over the depression between the calcaneum and astragalus. It then extended not to the superficial layer of the plantar fascia but deeper, to an attachment upon the plantar surface of the flexor hallucis longus. Its tendinous fibers continued, however, apparently to the fourth digit only.

M. soleus (figs. 13, 25, 27) is present in the otariids only. In *Zalophus* it was very thin at origin and robust at insertion. It arose by aponeurosis from the head of the fibula and by muscle fibers from the caudal border of the shaft as well as from the aponeurosis covering the peroneus brevis. Insertion was entirely fleshy upon the dorsal surface of the calcaneal extension deep to the tendon of the gastrocnemius. This muscle was very closely involved with the peronei brevis and digiti quinti. It is lacking in the Phocidae.

M. popliteus (figs. 12, 13, 27, 28) in the *Zalophus* was extensive but thin. Origin was by a tough tendon from the depression between the lateral condyle proper and the condyloid ridge, and by muscle fibers from the capsule of the joint, and was in intimate relationship with the plantaris. The belly expanded as usual and near the insertion, especially proximad, it divided into two thin sheets to allow for the passage of the internal lateral ligament. Insertion was upon the medial border of the shaft of the tibia from a point slightly distad of the head practically to the center of the shaft, but there was no osseous indication of its position. In the *Phoca* this muscle was rather thick but relatively narrow. Its tendon arose from the pit cradiad of the lateral condyle, origin being a bit smaller than in *Zalophus*, and some of the muscle fibers also arose from the capsule of the joint. Insertion was less than 25 mm. in length and at quite some distance from the head.

The flexor and extensor tendons to the digits have a habit, in diverse sorts of mammals, of wandering about, and the homologue of a hallucis or a digiti quinti muscle may be found to extend to some other digit besides the hallux or the fifth digit, respectively. Hence one can not always judge by insertion, nor by origin either, regarding the name of a muscle. When the innervation is not diagnostic the matter may become extremely difficult. Such is the state of affairs concerning the long flexors of *Zalophus* and *Phoca*. The one that extends to the hallux in the former does not do so in the

latter and vice versa. In the former the more medial arose directly superficial to the lateral. My nomenclature is based on the fact that in the *Phoca* the muscle which I term the digitorum longus was located in its normal position mediad to the hallucis, and in both my animals, the digitorum tendon is the one located nearer the calcaneum than the hallucis where they both pass over the heel. It is fully realized that the positions of the tendons at this point could be transposed, but it is necessary to have some criterion and as both muscles are served by the tibial nerve, homologizing by the innervation in such specialized mammals would not be dependable.

M. flexor digitorum longus (figs. 13, 27, 28) in the *Zalophus* arose deep to the popliteus and superficial to the flexor hallucis longus. Its origin was from the caudo-medial part of the head of the fibula and from the strong tibio-fibular ligament which stretched from the head of the latter bone to a point distad three-quarters the length of the tibial shaft, which ligament marked the medial border of the deep fascia of the shank. The tendon from this muscle passed over the more lateral of the two grooves upon the medial border of the caudal tibia, expanded and joined the tendon of the hallucis longus upon its deep surface. The two layers could be dissected apart, however, when it was seen that the digitorum longus sheet split into three branches, these going, respectively, to digits 1, 3, and 4. In the *Phoca* this muscle was considerably smaller than the flexor hallucis but was still a robust muscle. Origin was fleshy from the tibial side of the head of the fibula and from the adjoining border of the posterior tibial fossa as far as the internal lateral ligament. The tendon passed caudad of the internal malleolus and broadened as it extended deep to, and became fused with, the hallucis longus. After careful dissection it appeared that branches of this tendon extended to digits 2, 3, and 4.

This is Murie's flexor longus hallucis—a fact not mentioned by Miller—and its origin was simlar to *Zalophus*, but the precise insertion is not clear. Miller considered it in the same light as I do for *Phoca* at least, but I can judge little regarding his description of conditions in *Arctocephalus*.

M. flexor hallucis longus (figs. 13, 26, 27, 28) is a somewhat ambiguous name as far as concerns *Zalophus*, but for this genus flexor fibularis would be no better. In the *Zalophus* it arose deep to the flexor digitorum longus from the caudal part of the tibial border of the fibula and from the interosseous membrane, but at no point did fibers quite reach the tibia. The tendon then passed over the heel between those of the plantaris and digitorum longus, expanded, and formed the more superficial layer of the sheet common to this muscle and the digitorum longus. Further dissection showed that it split into but two branches, which extended respectively to digits 2 and 5. The

tendons of the two long flexors which ran to the four lateral digits entered from the deep side into four sheaths which stretched from a part of the plantar fascia, as mentioned elsewhere. In the *Phoca* this was an exceedingly robust muscle. It arose from the caudal head of the fibula and from two-thirds of this aspect of the shaft, as well as to a slight extent from the fibular part of the interosseous membrane. Muscle fibers ceased some 30 mm. proximad of the heel and the very broad tendon—the heaviest of the foot—passed over the groove upon the greatly specialized posterior process of the astragalus, in this animal actually longer than that of the calcaneum. The tone of this muscle and the form of astragalus—giving the action of a regular tendo calcaneus—is all that prevents the foot from assuming a platigrade position. The tendon of the flexor hallucis, after appearing upon the plantar surface, broadened and passed between the tendons of the plantaris and flexor digitorum longus, and partly fused with the latter tendon ectad. It split apparently into four branches, these going to digits 1, 3, 4, and 5. The one to the hallux again split, one branch extending to the dorsum and the other to the lateral side of this digit. This muscle is the flexor longus digitorum of Murie, although Miller evidently failed to notice the fact. The latter's descriptions are very involved, and as he failed to dissect apart the two layers of tendons, no differences of significance can be noted.

M. tibialis posticus (figs. 13, 27, 28) in the *Zalophus* had fleshy origin from the extreme medial part of the head of the fibula, from the fibulo-tibial ligament mentioned under the flexor digitorum longus, and from the entire posterior tibial fossa as far as the distal quarter of the shaft. Its very large tendon passed over the most medial of the two grooves upon the posterior aspect of the tibia, down the medial border of the tarsus and metatarsus, and inserted broadly upon the terminal phalanx of digit 1, this acting as an abductor of the digit. Embedded in the tendon just mediad of the proximal part of tarsale 1 was the tarsal sesamoid bone. In the *Phoca* the flexor digitorum longus covered all but the medio-distal border of this muscle. It was broad but thin and arose chiefly from the posterior tibial fossa for almost three-fifths of the length of the bone, from the interosseous membrane mediad to the flexor hallucis longus, and from the medial head of the fibula. Its rather small tendon passed over the groove caudad to the medial malleolus and inserted upon the lateral centrale. Miller evidently followed the tendon with greater perseverance than I employed and ascribed to it considerable complexity in its attachments over a limited area.

M. tibialis anticus (figs. 13, 25, 26) was the most medial of the muscles of the front of the shank. In *Zalophus* it was rather small and arose from the head of the tibia, from the proximal half of its shaft,

and from the deep fascia covering the extensor hallucis. Its broad tendon passed mediad to an insertion upon the medial margin of metatarsus 1. Origin in the *Phoca* was very similar, being from the better defined anterior tibial fossa and slightly from the adjoining interosseous membrane. Its tendon passed through the deep tibial groove upon the front of the instep, went deep to the extensor hallucis tendon and inserted upon the medial border of the base of metatarsus 1, as in *Zalophus.* There were said to be two tendons in *Eumetopias*, the second inserting upon the first tarsale.

M. extensor hallucis (figs. 13, 25, 26) was a weak muscle in the *Zalophus* arising from the interosseous membrane and slightly from the adjoining borders of both tibia and fibula. Its tendon passed over the instep between those of the tibialis anticus and extensor digitorium longus to insert upon the base of the first phalanx of the hallux. In the *Phoca* its origin was from the proximal part of the cranial ridge of the fibula. It lay mostly deep to the extensor digitorum longus and its slender tendon passed over the instep just laterad to that of the tibialis anticus. It then crossed superficial to the last and ventrad of the base of the first metatarsal, after which it extended dorsad once more to insert upon the lateral side of the dorsum of the first hallucial phalanx. This was said to be of unusual volume in *Eumetopias.*

M. extensor digitorum longus (figs. 12, 13, 25, 26) in the *Zalophus* arose very slightly from the lateral epicondyle of the femur, from the capsule of the joint adjoining, from a small area over the part of the tibial head adjacent to the fibula, and from two-thirds of the cranial border of the fibular shaft. In addition the deeper fibers were in intimate relationship with the extensor hallucis and with the peroneal aponeurosis. In the *Phoca* origin was from the craniolateral head of the tibia. In both the tendon passed over the middle of the instep and split into four branches, which extended to the four lateral digits. Murie reported no tibial origin for *Eumetopias* and *Odobenus.*

Stretching from the head of the fibula to the most prominent part of the external malleolus of *Zalophus* there was a sort of ligament, here termed the peroneal ligament. It is a development of the usual involved aponeurosis of the peronei, and in addition had connection with the aponeurosis of insertion of the hamstring muscles. Such an aponeurosis was present in the *Phoca* as well, but no definite ligament was encountered nor was direct involvement with the hamstring aponeurosis noted, possibly because of the more tender state of the tissue in the latter.

M. peroneus longus (figs. 12, 25, 26) arose from the lateral epicondyle of the femur. In the *Zalophus* it passed beneath the peroneal ligament and over a groove immediately caudad of the most prominent

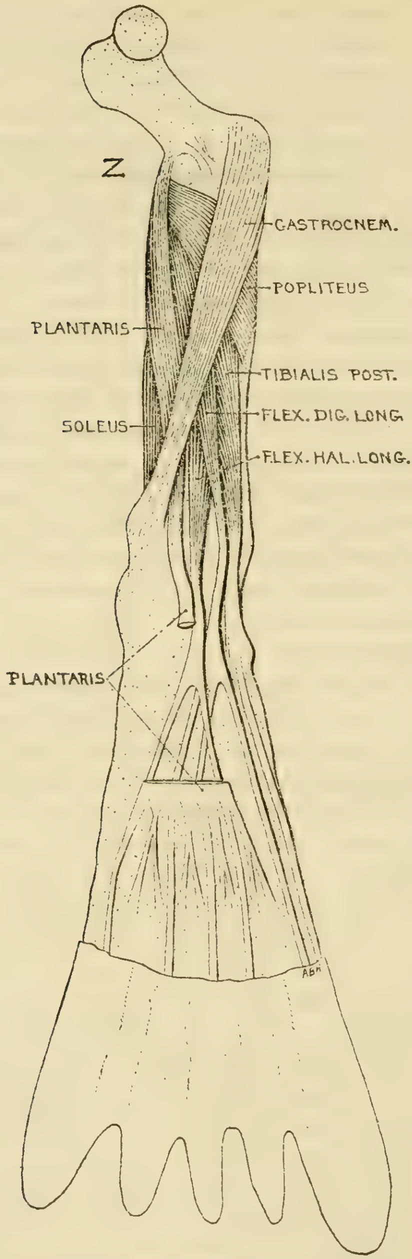

FIG. 27.—CAUDAL ASPECT OF THE MUSCULATURE OF THE LEFT POSTERIOR LIMB OF ZALOPHUS

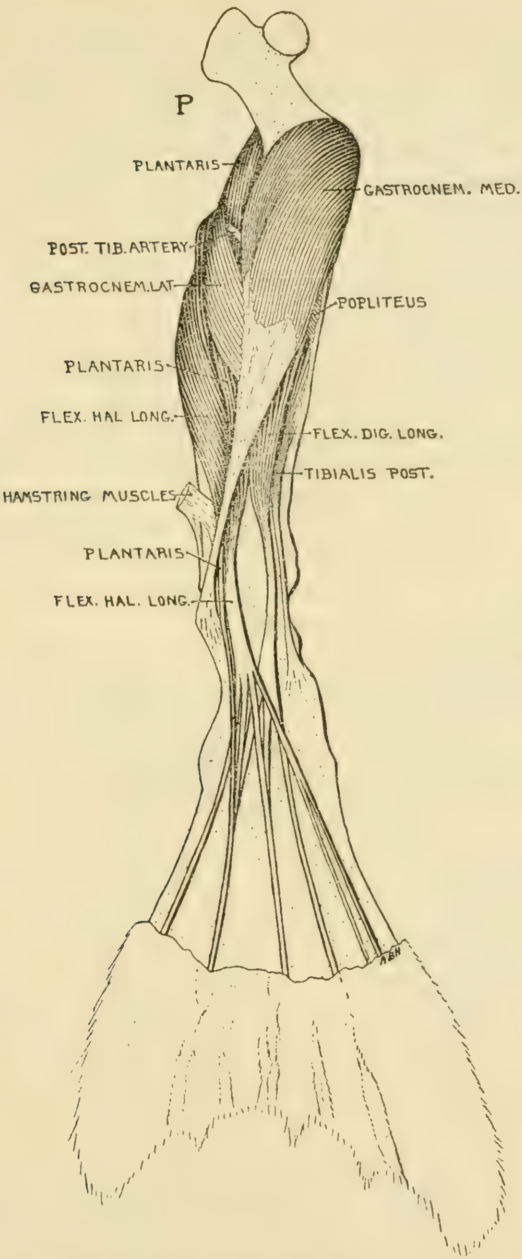

FIG. 28.—CAUDAL ASPECT OF THE MUSCULATURE OF THE LEFT POSTERIOR LIMB OF PHOCA HISPIDA

part of the external malleolus, over another groove upon the lateral calcaneum, to the plantar surface over the peroneal groove of the cuboid, and to an insertion upon the ventro-latero-proximal part of the first metatarsal. In the *Phoca* the tendon passed over a groove just craniad of the external malleolus, through the deep groove upon the lateral calcaneum, and then to the plantar surface through the peroneal groove of the cuboid, here so deep that it formed a bony tunnel arched over by a process of the cuboid in contact with metatarsal 5. There was also a groove for this tendon upon the first tarsale and insertion was normal upon the base of metatarsus 1. Miller considered that some of the fibers of this muscle took origin also from the tibia and fibula.

M. peroneus brevis (figs. 13, 25, 26). For a description of this muscle in the *Zalophus*, see the next. In the *Phoca* it was practically hidden by the peroneus digiti quinti. It arose from the proximal half of the cranio-lateral shaft of the fibula. Its tendon was in contact with that of the digiti quinti to distad of the calcaneum, at which point it diverged to insert upon the process directed ventrad upon the base of metatarsus 5. This has been reported as a separate muscle in the remainder of the eared seals that have been dissected, in *Arctocephalus* and *Eumetopias* arising deep to the digiti quinti and inserting upon the fifth metatarsal.

M. peroneus digiti quinti (figs. 13, 25, 26) in the *Zalophus* certainly occurred fused with the brevis division. This arose from the lateral head of the fibula and from half the lateral border of the shaft, from the peroneal ligament and from the deep aponeurosis of the soleus. The tendon passed over the lateral malleolus just caudad of the peroneus longus tendon, then beneath the latter, and over the peroneal groove upon the calcaneum, splitting into two branches, one going to the proximal termination of the first phalanx of digit 5 and the other to the metatarsal of the same digit. In the *Phoca* it arose by aponeurosis from the cranio-lateral head of the fibula. Its very slender tendon passed over the deep fibular groove directly caudad of the lateral malleolus, as in *Zalophus*. It then stretched distad along the lateral side of digit 5 as a well-defined tendon only as far as the basal phalanx. Miller said that in *Arctocephalus* it arose below the soleus, but this does not conform to his description of the latter muscle.

In *Odobenus* Murie found a peroneous quartus, and what he considered as the homologue of a peroneus tertius, the interpretation of the latter especially being doubtful, as it arose from the calcaneum. Its tendon joined that of the quartus division, and both therefore extended to the fourth metatarsal.

As with the manus, the short muscles of the pes are here omitted, the full account by Murie and Muller being deemed entirely adequate.

MUSCLE DIFFERENCES

Before the discussion of the functional differences between the Otariidae and Phocidae is undertaken it will be necessary to digest the more significant of the muscle differences and to tabulate them in condensed form, so that the variations may the more easily be grasped. Certain of the myological differences between the animals dissected are of such a character that it is difficult to compare them in words, especially concisely. Many of the muscles showing slight differences or of a character which are deemed relatively unimportant are omitted from the table and from the discussion. It is desirable to match muscular conditions of the Pinnipedia with one of the fissipeds, and solely because the domestic cat is far better known than any other this is selected for the purpose, and the nomenclature of its muscles reduced to terms comparable to those used for the pinnipeds. In the following table, then, those muscles are listed which have been found to differ in their origins or insertions, and the conditions in the cat (C) are given, followed by those in *Zalophus* (Z) and the *Phoca* (P).

Muscle	Origin	Insertion
Sternomast	C manubrium	lat. ½ occip. crest.
	Z presternum and craniad	lat. ⅓ occip. crest.
	P lat. presternum	mastoid proc.
Sterno-hyoid-thyroid	C 1st cost. cartilage	norm.
	Z manubrium deep to presternum.	norm.
	P 1st cost. cartilage	norm.
Scalenus ant	C ribs 2, 3	
Scalenus med	C ribs 3, 4	transv. proc. all cerv. vert.
Scalenus post	C ribs 6, 7, 8, 9	
Scalenus 1	Z rib 3	4th cerv. vert.
Scalenus 2	Z rib 1	5th cerv. vert.
Scalenus 1	P ribs 3, 4, 5	3d cerv. vert.
Scalenus 2	P rib 1	4, 5, 6th cerv. vert.
Scalenus 3	P rib 1	3, 4, 5, 6th cerv. vert.
Longus colli	C 2 norm. slips	norm.
	P 2 norm. slips	norm.
	Z 2 norm. slips, 1 complex atlantic.	
rect. cap. ant. maj	C cerv. vert. 2–6	norm.
	Z cerv. vert. 1–5	norm.
	P cerv. vert. 3–6	norm.
Panniculus carn	C carnivore type	
	Z modified carnivore type	
	P specialized type	
Pectoralis antibrach.	C manubrium	elbow.

Muscle	Origin	Insertion
Pectoralis maj. superfic.	C. cranial ½ manubrium	mid. ⅓ humerus.
Pectoralis maj. prof.	C manub. and sternebrae 1, 2, 3.	great. tuber. to ¾ humerus.
Pectoralis minor	C 6 sternebrae	prox. ½ humerus.
Pectoralis abdom.	C xiphoid	to latis. dorsi and pect. minor.
Pectoralis superfic. ant.	Z presternal tip to rib 5	to wrist.
Pectoralis superfic. post.	Z rib 6 to xiphoid	great tuber. to manus.
Pectoralis prof.	Z prestern. tip to xiphoid	1 delt. crest and to forearm.
Pectoralis	P dorsad prestern. tip to xiphoid and latero-caudad to near knee.	2 delt. crest.
Serratus mag.	C ribs 1–9 or 10 Z ribs 2–10 P ribs 3–12	norm. norm. norm.
Depressor scapulae.	C cerv. vert. 3–7 Z cerv. vert. 3–7, ribs 1–4 P cerv. vert. 3–7, ribs 1–2	norm. norm. norm.
Rectus abdominis	C norm Z norm P norm	cost cart. 1, 2 and sternum. cost. cart. 8, 7, 6, 5, not sternum. to sternum craniad to rib 1.
Quadratus lumborum.	C last 2 thorac. and all lumbar vert. Z last 3 thorac. and all lumbar vert. P last 2 thorac. and all lumbar vert.	ilium. ilium. sacrum.
Cephalohumeral	C from brachialis muscle Z prestern. tip; deep pect; delt. crest. P gt. and lesser tubers.	med. ½ occip. crest. med. ⅔ occip. crest. sagittal crest.
Humerotrapezius	C middorsad axis to 4th thorac. Z about middorsad axis to 4th thorac. P about middorsad axis to 4th thorac.	dist. ½ scap. spine. delt. crest and supinator longus. scap. spine and delt. crest.
Spinotrapezius	C all thoracic vert. spines Z caudal ⅔ thoracic vert. P caudal ⅔ thoracic vert.	2nd ¼ of scap. spine. prox. ⅗ of scap. spine. prox. ⅓ scap. spine.
Rhomboideus dorsi.	C middle cerv. to 4th thoracic.	vert. border scap.
Rhomboideus ant.	Z med. ⅓ occip. crest P nuchal ligament	prox. ⅗ scap. spine. glenovert. angle scap.
Rhomboideus dorsi.	Z middorsum P middorsum	vertebral border scap. glenovert. angle scap.
Atlantoscap. super.	C absent Z atlas P atlas	 vert. bord. scap. craniad of spine. vert, bord. scap. dorsad of spine.

Muscle	Origin	Insertion
Atlantoscap. infer.	C atlas and basioccip. Z atlas P atlas	metacromion. dist. ⅔ scap. spine. gt. tuber. and delt. crest humerus.
Splenius	C nuchal ligament Z nuchal ligament P nuchal ligament	entire occipital crest. entire occipital crest. mastoid process.
Trachelomastoid	C cerv. vert. 4–7 Z cerv. vert. 4–7 and thoracics 1–2. P cerv. vert. 3–7	mastoid process. mastoid process. mastoid process.
Biventer cervicis	C 7th cerv. to 5th thoracic vert. Z 5th cerv. to 4th thoracic vert. P 2nd cerv. to 2nd thoracic vert.	med. occipital crest. vertex. med. ⅓ occipital crest.
Complexus	C 3rd cerv. to 3rd thoracic vert. Z 2nd cerv. to 6th thoracic vert. P included with biventer cervicis.	med. ⅓ occipital crest. lat. occipital crest.
Rect. cap. post. maj.	C axis Z axis and 3rd cervical P axis	occipital. occipital. occipital.
Deltoid	C middle ⅓ scapular spine Z entire spine and caud. vert. border. P entire spine	deltoid crest. deltoid crest and supinator longus. deltoid crest.
Teres minor	C prox. glenoid border of scapula. Z lat. scapula, broadly P lat. scapula, narrowly	gt. tuber. of humerus. fused with infraspinatus. fused with deltoid.
Teres major	C prox. ⅓ glenoid border of scapula. Z prox. ⅓ glenoid border of subscapularis. P axillary ½ infraspinous space.	3rd tenth of humerus. middle of humerus. proximad middle of humerus.
Episubscapularis Subscapulo-capsularis.	Z present in *Zalophus* only P present in *Phoca* only	
Brachialis	C distal ¾ humerus Z prox. ⅔ humerus P prox. ⅔ humerus	norm. norm. norm.
Triceps long	C dist. ⅓ axillary border scap. Z infraspin. ridge and onto vert. border. P dorsal ⅓ infaspin. ridge and onto vert. border.	olecranon. forearm fascia. forearm fascia.

Muscle	Origin	Insertion
Triceps lat	C deltoid ridge Z humeral neck P delt. crest and distal scapula.	olecranon. forearm fascia. olecranon.
Triceps med	C prox. ⅕ humerus Z entire humeral shaft P entire humeral shaft	olecranon. olecranon. olecranon.
Anconeus internus	found in the pinnipeds only	
Palmaris longus	C entepicondyle Z entire medial face ulna, huge. P olecranon	norm. norm. norm.
Flex. digit. communis 1.	C from palmaris long. and flex. profundus.	4 lat. digits.
Flex. digit. communis 2.	C entire ulna; entepic; middle ⅓ radius.	5 digits.
Flex. digit. communis 1.	Z 4th tenth of ulna	digits 3, 4, 5.
Flex. digit. communis 2.	Z entepicondyle	digits 4.
Flex. digit. communis 3.	Z middle ⅗ radius	digits 1, 2, 3.
Flex. digit. communis 4.	Z entepicondyle	digit 1.
Flex. digit. communis 1.	P entepicondyle	
Flex. digit. communis 2.	P prox. ⅔ ulna	5 digits.
Flex. digit. communis 3.	P 3rd eighth of radius	
Flex. carpi ulnaris	C entepic. and olecranon Z olecranon P olecranon	pisiform. pisiform. pisiform and metacarp. 5.
Abduct. dig. 5 longus.	P in *Phoca* only, from olecranon.	digit 5.
Supinator longus	C middle ⅕ humerus Z prox. ⅔ humerus, broadly P prox. ⅓ humerus, narrowly.	distal radius. distal radius. distal radius.
Psoas minor	C last 2 thorac. and 1–3 or 4 lumbar vert. Z last 3 lumbar P last 3 lumbar	ilio-pectineal line on innominate. ilio-pectineal process. ilio-pectineal process.
Psoas magnus	C last 2 thorac.—7th lumbar Z last 2 lumbars and sacrum P last thorac., all lumbars, and sacrum.	lesser trochanter. lesser trochanter. med. tuberos. of tibia.
Iliacus	C ventral ilium Z ventral ilium P ventral ilium	lesser trochanter. lesser trochanter. medial tuber. tibia.
Gluteus quartus	Z present in *Zalophus* only—weak.	

Muscle	Origin	Insertion
Quadratus femoris	C ischium	distal greater to lesser troch.
	Z ischium	whole femoral shaft.
	P absent	
Semimembranosus	C ischial tuber	entepicond. femur and prox. tibia.
	Z caudo-ventral ischium	4th fifth of tibia.
	P caudo-ventral ischium	2nd to 4th fifth of tibia.
Semitendinosus	C ischial tuber	2nd fifth of tibia.
	Z spines 3d–6th caudals	distal ¼ tibial shaft.
	P {transv. proc. 1–3 caudals caudal ischium}	3d and 4th fifths of tibia.
Biceps femoris	C ischial tuber	prox. ⅓ tibia, and patella.
	Z {spines 2–7 caudals transv. plate 2nd sacral}	femoral condyle to distal shank.
	P {dorsal ischial spine transv. plate 3d sacral}	prox. ⅞ of shank.
Sartorius	C crest and vent. border ilium.	prox. ¼ tibia, and patella.
	Z {ventral angle ilium ventral angle ilium}	patella. medial tuberos. tibia.
	P ventral angle ilium	patella.
Vastus lateralis	C gt. trochanter and prox. ⅖ femur shaft.	patella.
	Z gt. trochanter and prox. ⅖ femur shaft.	patella.
	P gt. trochanter.	patella.
Vastus profundus	single in pinnipeds; double in cat.	
Pectineus	C cranial pubis.	distal base lesser troch.
	Z pectineo-psoal process	distal base lesser troch.
	P cranial pubis	distal base lesser troch.
Gracilis	C symphysis pubis	3d sixth of tibia.
	Z position comparable to symphysis.	medial third of tibia.
	P position comparable to symphysis.	distal ⅓ of tibia.
Adductor 1	C caudal ramus ischium	whole shaft femur.
Adductor 2	C cranial pubis	2d and 3d fifth of femur.
Adductor 1	Z caudal ischium	med. tuber. tibia and epicond. femur.
Adductor 2 and 3	Z caudal ½ pubis	dist. gt. troch. to entepicond.
Adductor 4	Z medial pubis	2d fifth of femur.
Adductor 5	Z cranial pubis	entepicond. of femur.
Adductor 6	Z cranial pubis deep to 5	lesser troch.
Adductor 1	P cranial pubis	middle ⅗ of femur.
Adductor 2	P caudal ½ pubis	base gt. troch.
Gastrocnemius lat	C large	norm.
	Z absent	norm.
	P small	norm.

Muscle	Origin	Insertion
Plantaris	C tendon over caudal calcaneum. Z tendon over medial calcaneum. P tendon over medial calcaneum.	
Soleus	present in the cat and *Phoca* only.	
Flex. digit. longus	C middle ½ tibia Z fibular head P fibular and tibial heads	to tendo flex. hallucis longus. digits 1, 3, 4. digits 2, 3, 4.
Flex. hallucis long	C middle 5/7 of tibia Z prox. ⅔ interos. membrane. P prox. ⅔ fibula	tendons to all digits. digits 2, 5. digits 1, 3, 4, 5.
Tibialis posticus	C prox. ⅓ tibia Z fibular head and prox. ¾ tibia. P prox. ⅗ tibia	norm. norm. norm.
Extens. digit. longus	C ectepicond. femur Z ectepicond.; tibial head; prox. ⅔ fibula. P tibial head	4 lat. digits. 4 lat. digits. 4 lat. digits.
Peroneus longus	C prox. ½ fibula Z ectepicond. femur P ectepicond. femur	all 5 metatarsals. metatar. 1. metatar. 1.
Peroneus brevis	C distal ½ fibula Z fused with next P prox. ½ fibula	metatarsal 5. metatarsal 5. metatarsal 5.
Peroneus digiti 5	C absent Z with last, prox. ½ fibula P fibular head	 digit 5. digit 5.

When one casually examines either a dissection of the animal itself or of a series of drawings of a pinniped he will likely be struck by the apparent vastness of the difference from what may be termed a normal mammal, but this difference is not as great as it seems, and a detailed study, muscle by muscle, will lead the investigator to the opposite extreme and mildly astonish him that a mammal which departs in many details so widely from the generalized type can adhere so faithfully to the fundamental carnivore plan of myological arrangement. The pinniped osteology is, of course, very specialized, and the muscle attachments must synchronize accordingly, which is the main reason why the musculature appears so complicated at first sight.

In the above table the origins of the *Zalophus* resemble those of the *Phoca* in a few more instances than they differ, while the differ-

ences of insertion outnumber the resemblances. The muscles above listed, both in origin and insertion, differ from those of the cat in about 14 per cent more instances in *Zalophus* than in the *Phoca*, but the differences in origin are more numerous than those of insertion. On the other hand, when these muscles of *Zalophus* are compared with those of the *Phoca* it is found that the origins are more conservative, while the insertions are more prone to differ.

Little or no account can be taken of muscles which may be relatively more or less robust because of the difficulty of comparing the cat, the lean otariid, and the fat phocid. The following comparisons may, however, be made, with the cat as standard:

Muscle conspicuously broader at origin: Pectoralis in both, and biceps femoris in *Zalophus*.

Body muscles that are shorter: In both genera the sternomastoid and scalenus, the latter in *Phoca* especially.

Occipital muscles with broader attachment: Cephalohumeral in *Zalophus*.

Occipital muscles with narrower attachment: Cephalohumeral and splenius in *Phoca;* biventer cervicis in *Zalophus;* and sternomastoid in both, especially the *Phoca*.

Limb muscles whose origins have shifted distad: Triceps medialis, palmaris longus, flexores carpi ulnaris and hallucis longus, and extensor digitorum longus pedis in both animals.

Limb muscles whose origins have shifted proximad: Brachialis, triceps longus, flexor digitorum longus pedis, and peronei longus and brevis, in both animals.

Limb muscles whose insertions have shifted distad: Pectoralis (part), humerotrapezius (especially in *Zalophus*), teres major, triceps longus, semimembranosus, semitendinosus, and biceps femoris, in both; deltoid, triceps lateralis, quadratus femoris, and adductores 1, 2, 3, and 5 in *Zalophus;* and atlantsocapularis inferior, psoas magnus, iliacus, and gracilis in the *Phoca*.

The inclusion or ommission of some muscles in the above groupings are at times largely arbitrary, for it may be difficult to be sure whether a muscle is attached only to the tibial head, for instance, or whether it also encroaches upon the femoral condyle. Also it must be taken into account that most of the limb muscles are relatively shorter than those of the cat usually merely for the reason that the bones themselves are shorter.

It is to be seen that only two of the body muscles of the Pinnipedia listed in the tables (pp. 101 to 106) have become shorter, and these to a very slight extent. One muscle of the occipital crest has become broader and four others of this region narrower in their attachment. The origins of five limb muscles have shifted distad and five others proximad, to a very slight extent in all cases save

that of the triceps, and 14 of the insertions of *Zalophus* and 11 of *Phoca* have shifted distad. Further scrutiny shows that almost all of these insertions that have shifted distad are muscles of the upper arm and thigh, while of the antibrachial and shank muscles whose origins have shifted half have moved proximad and half distad, an exception being the triceps longus. On the average, therefore, the tendency has been toward a lengthening of the limb muscles, not actually but in respect to the positions of their bony attachments.

DISCUSSION

In the following pages *Zalophus* and *Phoca* will be discussed as two mammals that are chiefly aquatic, differing from each other in certain respects and from the normal terrestrial carnivore in others. There will be no discussion in the present paper of the probable derivation and but little regarding the relationship of the Otariidae and Phocidae, nor of certain broad principles and laws intimately correlated with the development of a mammal for an aquatic life. It may be mentioned, however, that the writer considers the serious comparison of the otariids with the bears and of the phocids with the otter (as Mivart, 1885), in an attempt to prove that the ancestry of these two pinniped families can be traced to members of groups now living, to be a rather unprofitable pastime. There are many resemblances, it is true, but it is very probable that the eared seal phylum is older than the bears. Not only is the Pinnipedia a very ancient order but the carnivore stem has had very numerous branches, and it is extremely unlikely that the protopinniped was at all like any living fissiped.

In all the pinnipeds the relaxed position of the anterior nares is almost closed and naturally remains so between respirations even when the animal is on land, although I have seen a sea lion maintain its nostrils in a dilated position for several minutes at a time, and also a phocid when panting after considerable exertion. Tight closure can be effected both by contraction of the naso-labialis, pulling the mystacial pad against the nostril, and by contraction of the fibers of the mystacial pad itself, which radiate toward the surface and probably have some voluntary muscle action. Expansion of the nasal opening is effected by flexion of the maxillo-naso-labialis, which pulls the mysticial pad laterad. This pad is much broader and thicker in the phocid, but there was apparently no difference in the operating mechanism of the anterior nares to account for it. Possibly the reason for the difference in size of the pads may be found in some variation of the tactile function of the vibrissae. In breathing on land the otariid keeps the nostrils virtually closed between breaths, opens them moderately at exhalation and widely during inhalation.

In the water this animal often swims partly on its side and when coming to the surface for breath, will inhale through the corner of the mouth as well as through the nose, as a human swimmer often does. Perhaps more frequently, however, it will break water with the tip of the nose and breathe through this member only, as the phocid usually, if not always, does. It may be mentioned in this connection that the epiglottis of *Zalophus* appears to be unusually small for the size of the animal, which one would not expect to be the case in an aquatic form which habitually comes to the surface for quick breaths.

I have encountered no statements regarding the possible duration of submergence of the Pinnipedia which I regard as both significant and trustworthy. In captivity an animal seldom experiences any incentive for lengthy submergence and I have never seen one do so for more than about two minutes. If frightened in the wild, the animal which reappears can not always with confidence be regarded as the same one which has disappeared. It seems certain that all pinnipeds must be able to stay beneath the surface for some considerable time, while it would seem absolutely essential that the boreal members of the Phocidae, at least, which must often have to swim beneath extensive ice floes, should have this faculty especially developed. Of undoubted importance in the present connection is the development in this order of a large hepatic sinus, consisting of a remarkable dilation of the vena cava dorsad of the liver. For the Phocidae this was said by Murie (1874, p. 545) to have been reported and illustrated by Barkow (presumably H. C. L. Barkow in the early nineteenth century), but I have been unable to find the article to which he refers. Murie (1874) states that in his *Eumetopias* the sinus occupied "a volume, one might almost say, greater than the glandular hepatic organ itself." In examining the viscera of the *Phoca hispida* which I dissected, Paul B. Johnson encountered such a sinus, dilatable to contain perhaps 2 quarts, but in the younger *Zalophus* it was much less developed. It is, therefore, possible that this sinus is developed with age and that it is largely lacking in juveniles. It is, of course, apparent that it serves as a reservoir to hold an extra amount of blood and hence to prolong submergence by just so much. Throughout sealing literature one often encounters statements to the effect that pinnipeds appear to be veritable sacks of blood.

While on the subject of the viscera it may be well to mention, in passing, the habit of the Pinnipedia of swallowing stones, sometimes as large as an egg and aggregating as much as 3 pounds in weight. The reason for this action has not been determined.

In the *Zalophus* the ear is slender and had a length of 28 mm. The external opening of the auditory tube is small and the pinna of

the ear laps at the base, so that when the ear is pulled backward by the cervico-auricular musculature, flexion of the mandibulo-auricular complex furls the base of the pinna and effects complete closure of the tube. There is no conspicuous valve within the tube. In *Phoca hispida* conditions are considerably different, for there is no external ear or pinna. Near the orifice, however, there is a small fibrous plug which acts as a valve to close the tube upon contraction of the mandibulo-auricular. No action of the cervico-auricular muscles could be detected in living animals. Dissections of Ernst Huber, however, indicate that there is considerable specific variation in the mechanism for closing the ear of the Phocidae.

The auditory tube is not longer in the phocid, and so the external auditory orifice is really no farther dorsad in this animal than in the otariid, but the sagittal line is higher in the latter, and this increases with age, so that in reality the top of the head is higher above the ear and the head must be thrust higher out of water for the animal to hear. In the phocid the eyes also are directed more dorsad (15° to the vertical as against 50° in the otariid), and the external nares as well (45° to the cranial axis as against about 20° in *Zalophus*), so that eyes, ears, and nostrils are so placed in the earless seal that these organs of sense may be utilized while the animal exposes the minimum amount of its head above the surface of the water—a definite aquatic modification developed to a greater degree than is the case in *Zalophus*.

Quite diverse stimuli seem to have been instrumental in molding the characteristics of the neck in the otariid and the phocid. In adult bulls of the former the neck acts partially as a repository for surplus fat accumulated to sustain the animal during the breeding season. Unfortunately proof is at present impossible, but I am strongly of the opinion that at the approach of the breeding season when the otariid bulls must do battle for the females, the increase in the swelling of the neck is also partially due to an enlargement and coarsening of certain of the cervical muscles, this action being caused by a hormone or similar secretion of the awakening sex glands. This had puzzled me for some time until O. J. Murie informed me that he had noted a great increase in size of certain neck muscles (chiefly the sternomastoid I believe) during the rutting season of the caribou (*Rangifer*), the purpose of which is evidently to add to the fighting ability of the bulls. This is entirely comparable to the relatively great increase in the length and size of some of the perineal muscles of female mammals at the imminent approach of parturition.

This cervical swelling does not take place in females and young bulls of the Otariidae. Even in old bulls submersion lightens the weight of the neck, and the more powerful musculature of this sex may theoretically handle the large neck even more agilely under

water than is the case with females and young males. At any rate, even though the neck is relatively no longer than in the cat, it always has the appearance of being long and flexible, capable of great contortion and great precision of movement. This has been developed in the pursuit of agile prey, necessitating darting movements of the head here and there, and also in the sinuous movements which this family is seen to use while swimming, thrusting the head this way and that as an accessory rudder in aid of the more posterior one (the hind feet), with the middle thorax as the fulcrum of leverage. For the reason that natation is almost exclusively by means of the fore feet, this sinuous development of the neck has not been inhibited by a more powerful stimulus, as seen to best advantage in Cetacea and to a lesser extent in the Phocidae, in both of which the neck acts as part of the fulcrum upon which acts the lever of the posterior end of the animal during swimming. The mobility of the head and neck of the otariid is further increased by the part which they play in terrestrial locomotion, during which the neck violently sways back and forth, not only to maintain proper balance, but as a direct aid, chiefly through the broadened cepahlohumeral, to rhythmic motions of the forelimbs. Besides the cephalohumeral, other broad muscles which aid in diverse movements of the head are the anterior rhomboid, splenius continuous with the trachelomastoid, and the broadened insertion of the sternomastoid; and the exceedingly complex third or atlantic division of the longus colli must also have an important bearing in this connection.

There is apparently no reason why an agile neck would not be of great advantage to a *Phoca* also, and it is not meant to imply that this member is actually stiff. But the fact remains that extensive observation of both sea lions and seals shows that the latter uses its neck in a different manner. It seems actually to have extensibility and may be stretched to a surprising degree, but in retrieving a dead fish there is not the speedy action and "catch on the fly" of the otariid, but a more deliberate nuzzling and capture, nor is the head and neck moved much as an aid to terrestrial progression. The articulations of the vertebrae are doubtless as free, but the muscles are apparently used in a different manner. Largely instrumental in this lack of agility is the fact that in this family, as in the Cetacea, practically all the motive impetus during aquatic progression is furnished by the extreme posterior end of the animal, and the neck as well as the anterior thorax acts as the fulcrum upon which works the powerful musculature of the lower back. The head, together with the forefeet, doubtless plays a most important part as a rudder, but in very circumscribed movements, for a slight twist dorsad or laterad would be all that was necessary. In other words, no animal that

propels itself through the water at speed by means of its posterior parts can wave its head around in all directions, but an otariid, with center of motion near the middle of its mass, can move the head in any direction it pleases if it at the same time employ its rear end in antagonistic or compensating movements.

Accompanying this state of affairs is found a distinctive condition of the muscles with attachment to the occipital crest and ventrad. In contrast to the situation in *Zalophus*, in the *Phoca* the cranial attachments of the cephalohumeral, humerotrapezius, and anterior rhomboid are narrowly confined to the vicinity of the vertex, while the middle and ventral parts of the occipital crest are free of all muscles which are more characteristic of the normal occipital crest, the superior oblique being the only one found here. As the above have narrowed mediad, so the others have narrowed ventrad, and the insertions of the sternomastoid, trachelomastoid, and splenius are confined to the mastoid process. Thus the muscles here discussed are better situated to work in two planes of movement in the *Phoca*—directly dorsad and directly laterad—which are most effective in rudder movements, rather than muscles fitted for movement in all directions, as in the otariid.

The number of vertebrae in the thoracico-lumbar series, 20, is the same as in the majority of fissipeds, which is one more than the primitive number as mentioned by Todd (1922), while the tendency in most orders is toward an increase in the number of this series. The almost total lack of definition of the neural spines in the anterior thoracic region of *Phoca* conforms to the claim by Harrison Allen (1888) that these spines are practically absent in those mammals which do not use the anterior limbs for support, such as *Dipus* and the bats. This statement furnishes food for thought, but the conditions are far from being as simple as implied, for in the Cetacea, which have surely abandoned manual support for a longer time than any other mammal, the neural spines of the anterior thorax are always well developed and at times are enormous. It might be thought that in view of the greater development of the back muscles in the Phocidae the spines might be higher than in the Otariidae, rather than so much lower, but such is not the case, and it is probable that the narrow, deeper back musculature of *Zalophus*, with the longer spines, has developed for movements of all sorts, especially in the sagittal plane, while the immensely broad back musculature of *Phoca*, with wide vertebral articulations and very low spines is in response to movements that have been so largely lateral. Photographs of *Mirounga* (see fig. 29) show that from a prone position on land this animal can elevate the anterior part of the body, including most of the thorax, to an absolutely vertical position in a manner that one would judge to be beyond the power of any mammal. There

is no skeleton of this genus at hand but I can not find any modifications in other Phocidae examined that might permit such an unusual position to be assumed.

No very significant differences in the thorax proper can be detected, save a tendency toward broadening in the phocid and apparently the lengthening in the otariid, possibly due in the latter to the advantage of having bony protection against hydrostatic pressure over the greatest possible area of the abdomen. The presternum that is well developed in both animals has undoubtedly been lengthened by a forward extension of the pectoralis, which is of such prime importance to the swimming of the otariid, and probably secondarily so in the phocid.

In the present paper there will be no attempt to calculate by formulae the leverage and potential strength of the limb segments and their muscles. Such treatment of the subject gives the result a profound and scholarly appearance, but the writer views with the greatest distrust all such treatments, for they can not take into consideration the differences of fascial attachment, and no one can tell exactly what any particular muscle either can or will do.

The anterior limb of the Pinnipedia as it now occurs is the result of three stimili which are hard to unravel—the fact that the proximal part is within the body, operative in both; phylogenetic influences, of an unknown degree of resemblance; and the fact that the forelimb is the primary organ of propulsion in the Otariidae and practically inoperative for this function in the Phocidae. In the otariid the foreflipper is one of the most important, and in the phocid, one of the least important, parts of the body. On land the former animal uses this member as normally as its proportions will allow. It is extended at the wrist at a right angle to the antibrachium, the toes being directed almost directly laterad. In the latter the manus may be used to help the animal from the water or over a rough spot, but its shortness and the thick blubber layer often present over the chest raise the manus too far from the ground for it to be of great use. Hence it is usually held somewhat pendant and abducted (from the forearm). As far as I can tell the most natural, static position of the anterior limb in both animals is with the humerus at slightly less than 90° to the scapular spine. In the otariid the antibrachium is almost extended, and in the phocid flexed to almost 90°. In the former the manus is almost on a line with the antibrachial axis, and in the latter, abducted to at least 45°—usually more. The static posture of these segments with relation to each other is shown in Figure 30.

In the water the otariid moves with broad sweeps of the powerful manus, recovery being made with the radial border of the arm pre-

sented craniad, while the rear limbs play a very minor part as far as I have observed, never being used in rhythmic motions, but in various steering movements. During brisk swimming the forefeet of the Phocidae are folded against the body save when the animal wishes to make a sharp turn, at which time the outside flipper will be abducted and thrust against the water, as a man would push against a wall in making a similar movement. When a seal is merely loafing about in the water, with slight turns, rolls and such idle actions without definite idea of progression, the hind limbs may be entirely immobile while the forefeet maintain an intermittent "fiddling" movement, such as a man would employ while treading water. I have no doubt that when the seal is suddenly alarmed it employs its forelimbs in active swimming movements in any way which might be of assistance in starting quickly.

It is almost impossible to determine the degree of pronation and supination of which the whole arm is capable, for so much of it is within the body covering that in the entire animal one can not follow the interaction of the joints, and after sufficient of the muscles have been cut away to determine this the results are worthless because many of the inhibitions to movement normally raised by taut muscles and bulk of tissue have been removed. It is probable, however, that at least in *Zalophus* there is less of such movement possible than in man, while in both there is more than in such a fissiped as the cat.

Few conclusions regarding the scapula may be reached, and its chief stimulus for specialization in the Pinnipedia is doubtless as a scaffold upon which are hung the arm muscles, rather than as an attachment for muscles of the thorax and neck. It is relatively more robust in the *Zalophus*, as one would expect, but contrary to expectations, the axillary border is relatively the longer in the *Phoca;* for this animal has less need for a long lever arm for the triceps. In the Otariidae at least the scapula is unusually mobile, and slides about beneath the skin when the animal is in terrestrial movement in exaggerated manner. When resting with head low the scapulae may be in contact, projecting for several centimeters above the dorsal line, or by means of the serratus magnus and depressor scapulae muscles they may be forced well ventrad, which correspondingly lifts the body. Incidentally it may be mentioned that in most of the articulated skeletons which one sees the thorax is elevated above the ground to an unnatural extent.

In the *Zalophus* the supraspinatus is large and powerful as an aid to extension of the humerus but in the *Phoca* [5] it is considerably weaker, as one would also expect. In both animals the infraspinatus

[5] At least in *Mirounga*, among the Phocidae, the supraspinous fossa is relatively quite as large as in the Otariidae.

(a rotator) is very weak while other muscles have encroached upon the infraspinous space of the scapula, which is especially the case in the phocid, for here this space is relatively considerably larger than the supraspinous fossa. There is no very clear reason to be seen for the extension caudad of the glenovertebral cartilage of the *Phoca*, although it is self-evident that it has taken this course in response to stimuli supplied by the muscles attached thereto.

The percentage of arm length (humerus, radius and manus), based on the bones only, to body length is in a cat skeleton 82, *Zalophus* 66, and *Phoca* 48 per cent, so it is seen that in comparison with a fissiped the phocid arm is much reduced, while that of the otariid occupies an intermediate position. In the same order as above, the length of the humerus compared to body length is, respectively, 31, 18, and 14 per cent; of the radius, 30, 20, and 14 per cent; and of the bony part of the manus, 21, 29, and 20 per cent. It is thus seen that there has been a shortening of the two upper segments of the pinniped arm and that the proportions of one segment to the other have remained almost the same as in the fissiped, save possibly that the rate of reduction in the size of the humerus has been a bit more rapid in the case of *Zalophus*. There has been no change in the size of the manus of *Phoca* relative to the entire arm, but that of the *Zalophus* has increased in relative size (compared to the more proximal segments) about one-third. Presumably, however, this osteological increase in the size of the otariid manus has not been sufficiently rapid to meet the needs of the animal and a still larger area for furnishing propulsive force has been acquired by the development of cartilagenous extensions to the digits. As an alternative one must consider the unlikely possibility that the presence of these cartilages is due to some stimulus other than that caused by the need of a longer manus in swimming. At any rate, they have made the functional length of the manus (measured to its tip) of the *Zalophus* about 40 per cent of the body length, or, from a relative standpoint, fully twice as long as in the *Phoca*. From still another aspect, the effective length of the anterior limb operating against the water is the distance from the axilla to the tip of the flipper. In the *Zalophus* with the axilla at a point just proximad to the middle of the ulna, this amounts to 52 per cent of the trunk length. In the *Phoca*, the axilla is opposite the ulnare and the corresponding percentage is about 19. As the anterior limb is used for such very different purposes in the two families, however, a comparison of the visible portions does little but call attention to their dissimilarities.

In the Otariidae the extended arm may be operated to good advantage as a swimming organ by muscles coming from other parts of the body. Thus the cephalohumeral is attached in part to the

deltoid crest but it also has connection with the tissue about the presternum and the border of the pectoralis. Its chief action is upon the head and neck but it also extends the humerus both in swimming, and upon the land by means of lunging, forward and back movements of the head, and is thus of definite aid in terrestrial progression. It is also involved with action of the anterior part of the pectoralis, which by means of its insertion as far distad actually as the palmar tissue, adducts the arm with much power. Of the greatest importance in strong backward sweeps of the flipper are the intimately connected posterior portions of the pectoralis, the latissimus dorsi, and most of the panniculus carnosus, all of which have a long power arm upon the anterior extremity. In the *Phoca* these muscles perform other work and will be discussed elsewhere.

Relative to length of body the humerus of *Zalophus* is less than 65, and of the *Phoca* about 45 per cent of the length of this bone in the cat. It is proportionately massive, with prominent and broad processes and ridges. Both of these details denote great power of the muscles attached. The humeral head differs somewhat in the two animals, indicating that the normal position of the humerus in *Phoca* is slightly more flexed and abducted than in *Zalophus*. Extension and flexion of the humerus is limited largely by the fact that it is entirely within the body covering and that the integument limits the movements of the forearm also; but abduction of the humerus is fully as great as in many fissipeds—*Canis* for instance. As the arm is largely within the body, flexion of the part distad of the humerus, by the single biceps and brachialis, is limited, while extension of the humerus is well provided for by a complex triceps with a leverage much greater than in the normal fissiped.

In the otariid the great height and massiveness of the greater tuberosity is for supplying increased leverage to the large supraspinatus which helps extend the humerus—a motion of much importance in recovery after a backward sweep of the foreflipper. This movement is not of importance to the *Phoca*, so the supraspinatus is small and the greater tuberosity lower than the femoral head. The enormous development of the deltoid crest, extending distad from the greater tuberosity for two-thirds the distance to the condyle in *Zalophus* and half the distance in *Phoca*, is of the utmost importance in not only supplying several times the leverage to the shortened bone that these muscles could furnish to a humerus of the human type, but also, through the great elevation of the deltoid crest, in presenting an efficient lever arm for strong rotation, needed in the "feathering" action of the flipper of *Zalophus* in swimming. The cephalohumeral, humerotrapezius, and pectoralis have probably had far more to do with the elevation of this crest than the deltoideus. In the *Phoca* the deltoid crest, although not quite so long is fully as high—

higher distad. It can not play the same part in the economy of this animal as in the otariid, for the forelimb is practically useless as a swimming organ. Of course the high deltoid crest may be a relic from a time when the foreflipper may have been so used, but I believe another explanation is the proper one, and this is that the high deltoid crest of the *Phoca* was developed in response to stimuli provided by strong antagonistic action of the muscles attached thereto; in other words, that it has acted as a static fulcrum while the animal is swimming. The more caudal part of the pectoralis and the latissimus dorsi are both of decided aid in the rhythmic lateral swimming movements of the posterior body. These insert upon the deltoid crest, which is held static as a fulcrum by the atlantoscapularis inferior and humerotrapezius. It is not meant to imply that this has been the only stimulus, but it was probably the most important.

The lesser tuberosity of *Phoca* is enormously developed and is much higher than either the head or the greater tuberosity; but in *Zalophus* it is low, although very prominent. The condition in the phocid is not attributable to any complexity of muscles attached to this tuberosity, for almost the sole influence is the subscapularis. At least a part of the height of the process is due to the fact that in this animal the normal position of the humerus is a bit more abducted; but this seems insufficient to account in full for the condition and other logical reasons are obscure. The medial epicondyle, giving rise to a number of the forearm flexors, is larger than the lateral in *Zalophus*, as is the usual case in fissipeds, but both epicondyles are unusually massive. The flexors of this animal are, of course, of the utmost importance in operating the powerful backward sweeps of the flipper employed in swimming. In the *Phoca* the lateral epicondyle is fully as large as, if not actually larger than, the medial, and it is readily seen that in the phocid function of the arm while swimming, extension, in the way of brisk dorsal motions, is fully as important in steering movements as ventral ones. In consideration of the difference in the function of the forearm in the two animals it is rather unexpected to find precise similarity in the direction that the origins of the antibrachial muscles have migrated, which may be interpreted as evidence of some strength in favor of the uniphyletic origin of these two families of pinnipeds. This migration, as already mentioned, consists of a movement distad from the femur to the antibrachium of the palmaris longus, flexor carpi ulnaris (part), and flexor hallucis longus. In both animals there has been a movement distad of other muscle attachments which are characteristically of the humerus, but it is likely that this has been due to a more speedy rate of shortening for the *distal* than for the proximal part of the humerus.

It is quite remarkable that during the reduction in the size of the pinniped arm the relative proportions of the humerus and radius have remained virtually the same both in the *Zalophus* and the *Phoca*, as in the cat. There are two other measurements of this segment that are also worthy of mention—the length of the ulna and the width of the radius. In the cat the length of the ulna is 114, in the *Zalophus* 123, and in the *Phoca* 131 per cent of the radial length. This is not a great difference but the disparity is not in the expected direction. A great length of the olecranon is associated with strength of extension of the antibrachium, which one would expect to be an attribute of Zalophus—not a *Phoca* with its small, weaker manus. One can readily understand how an increased width of the antibrachial bones is correlative to the use of the forelimb as a swimming organ, this being an inevitable result of the turning of this limb into a broad, thin paddle. The Cetacea show this character to a strong degree and it is an expected characteristic of *Zalophus*, in which the greatest width of radius is 29 per cent of its length, but why this same proportion should be 35 per cent in the *Phoca* is unknown. Save for the deep grooves upon the distal part of the radius of *Phoca*, the other details of this bone mentioned in the osteological description are without any especial significance in the present connection. These grooves would be developed by agility rather than strength, and it is likely that they have been deepened by the same sort of "fiddling," water-treading movements of the flipper already mentioned, but there may be additional reasons for their appearance. There is no indication in the pinnipeds of any twisting of the shafts of the antibrachial bones, as so oftens occurs in fissipeds for the purpose of directing the manus straight craniad for increased facility in walking.

The proximal part of the ulna is of great depth, especially in *Zalophus*. This is due in this animal to the enormous width upon the medial face of the bone, of the head of the palmaris longus, arising from all this broadened portion, while in the *Phoca* this muscle is confined to the olecranol border, and the medial face of the ulna is occupied by a part of the origin of the flexor digitorum communis. Another muscle that has apparently acted to deepen the proximal part of the ulna of *Zalophus* is the extensor pollicis longus, occupying the ulnar two-thirds of the lateral face, while in the *Phoca* the origin of this muscle is very much narrower.

After transection of the antibrachial muscles it was found that through the forearm, chiefly the radius of course, the pronation-suspination movement of the wrist in respect to the humerus is about 40° or 45° in *Zalophus* and fully 80° in *Phoca*.

In *Zalophus* the manus continues from the antibrachium in almost a straight line, in static position the axis diverging from this by not more than 15°, with adduction almost zero and abduction to 45° (in the partially dissected specimen). In the *Phoca* the static position of the manus is at an abducted angle with the forearm of about 45°. Adduction from this position is almost entirely inhibited by the tension of the abductor digiti quinti—probably slightly more yielding in life—but maximum abduction is to an angle of 90° with the forearm. As already mentioned the proximal articular surfaces of the *Zalophus* scapholunar and ulnare, and of the metacarpals extend farther upon the dorsum of these bones than in the *Phoca*, but it was found that in the preserved animal the chief center of movement was at the articulations *distad* of the scapholunar and ulnare, due to the looseness of the capsular tissue at this point. Extension of the manus allows the metacarpals to be placed at a right angle to the forearm but no more, while almost the same amount of flexion is permitted. Provision is not made at the articular surfaces of the carpal bones of the *Phoca* for the same amount of extension, but this is nevertheless permitted by the looseness of connection of all the carpal bones. This same looseness allows flexion to the excessive point where the metacarpals are parallel with the bones of the forearm (after removal of the integument and fatty tissue). As there has been no twisting of the antibrachial bones the manus, in relaxed posture, presents its radial border almost directly craniad. Presumably this position is the best in both animals for the work which the manus has to perform, as it certainly is for terrestrial locomotion in *Zalophus*, disposing of the long tip of the manus in a way that will interfere the least with walking.

There seems to be little of functional significance in the carpus of *Zalophus*, as it is just the sort one would expect to find between the broad antibrachium and the metacarpus. There are several points about the carpus of *Phoca*, however, which attract attention. It is rather narrow proximad, which has probably been brought about by much movement of the manus in the plane of abduction-adduction. Abduction is very materially assisted by the peculiar abductor digiti quinti. As this has become more specialized it has pulled the manus more and more laterad until now its natural tone prevents adduction of this segment even as far as the antibrachial axis. Abduction to 90° is possible, however, as already mentioned, and this is correlated with a specialized, "mitred" condition of the carpus as a whole, suggestive of the mitering at the corner of a picture frame. The carpus alone has responded to this stimulus—not the distal extremity of the antibrachium. In brief this consists of a slight rearrangement of the carpal elements so that the metacarpal base of the first digit has

been shifted distad and of the fifth, both proximad and laterad, making the latter more opossable than is the pollex. The same agency that has operated to constrict the proximal part of the carpus has crowded the carpales so that these bones have become somewhat pyramidal and fit together so as to occupy the minimum of space.

In the *Zalophus* the manus externally is a rather broad and long paddle, tapering almost to a point, thicker upon the cranial or radial border and thin caudad. It is tough and elastic but the articulations of the metacarpals and phalanges are not as freely mobile as in many mammals. The palmaris longus is developed to a phenomenal degree and probably has an involuntary action in resisting an undesirable amount of extension of the manus during swimming, and by means of its insertion chiefly upon digits 1 and 5, in maintaining a slightly concave palmar surface. Extension of the pollex beyond the manual axis is largely inhibited also by all the other flexors which go to this digit and the interaction of the tendons concerned, as well as those of the remainder of the manus, is probably complicated and well developed for best efficiency. Specialization of the palmar tendons is not so strikingly marked in *Phoca*, but there is a broadening of the flexor carpi radialis to form a second deeper palmar fascia, and the middle part of the flexor digitorum communis has broadened greatly.

Such highly specialized aquatic animals as the whale and the turtle retain a short pollex, but this is not the case in the Pinnipedia. In the *Phoca* this digit is the longest and the most robust, the others being evenly and slightly subequal in sequence toward the fifth. In *Zalophus* the pollex is much the longest and much the most robust, while the fifth digit is relatively short. The flipper therefore tapers rather gradually to a point, and the entire axillary border is very thin—a condition which may be presumed of importance to the animal. The metacarpals and phalangeal bones of the Otariidae only are slightly flattened, which is a character which probably inevitably, sooner or later, follows the assumption by the manus of a paddle shape. This flattening is especially pronounced in the terminal phalanges of *Zalophus*. As mentioned elsewhere there are cartilagenous extensions of the digits in the Otariidae. The stimulus for this has evidently been at least to some degree attributable to a need for a longer manus having outstripped the lengthening ability of the phalanges The subject of the formation of these cartilages can not of course be exhausted with any such casual statement, but a number of theories which may be advanced to account for them are too speculative to merit acceptance at the present time.

There are interdigital membranes in *Phoca* while in *Zalophus* these have developed to the point where the whole manus is virtually a homogeneous paddle. This webbing need not be discussed, for it,

together with mechanisms closing the nostrils and ears, is a fundamental attribute which almost all aquatic animals develop at a relatively early stage in their aquatic evolution. The nails of the manus in *Zalophus* have deteriorated until they exist merely as horny spots within integumentary pits. As the animal has made no use of them, for scratching itself, as weapons of offense, or as tools to aid in the capture of food, they have naturally atrophied. The nails of *Phoca* are large and well formed. The external portion of the anterior limb is too short for these to be used for scratching any considerable area of the body, and even if for this use exclusively they would doubtless have become slender; and so far as is known they are of no use in the securing of food. Thus their use for scratching holes through the ice, as claimed by sealers, is the most likely theory to account for their robust development.

In the otariid the interdependence of the different parts of the posterior half of the body during terrestrial locomotion is extremely close, and in the phocid this relationship is even closer, but during the act of swimming only. It will be recalled that the hind limbs of the Otariidae are used during movement on land in a plantigrade manner by causing the axis of the sacral vertebrae to assume a vertical position, while the hind limbs are not of primary importance during natation; and that the Phocidae move upon land exactly as they would had they no limbs at all, while progression through the water is solely by means of oscillating lateral movements of the rear end. In the otariid the segments of the hind limb proximad of the heel are used upon land only as immobile supports, for they are too closely bound down to the innominates for much independent movement. Their terrestrial function therefore depends solely upon the great elasticity of the lumbar region, through the intervertebral disks. The inability of the Phocidae to use their hind limbs on land depends upon several conditions, one of which seems to be inability of the lumbar region to bend ventrad to the same degree as in the eared seals; but yet the vertebral column of the phocids is very elastic in certain directions, and *Mirounga* at least may stretch dorsad so that the backbone is bent into a veritable right angle and a rather sharp one at that. (See fig. 29.)

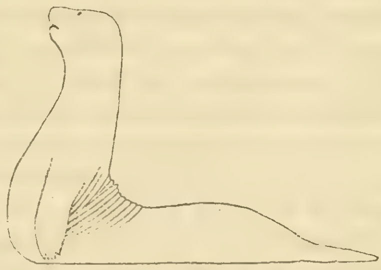

Fig. 29.—Position assumed by Mirounga illustrating possible degree of vertebral bending (after a photograph in the Illustrated London News of July 17, 1827)

The long back muscles of *Zalophus* are essentially similar to those of a fissiped, and the hypaxial musculature is also unspecialized in

strength; but there are other muscles controlling the lumbar flexibility. These comprise chiefly the panniculus, latissimus dorsi, the posterior part of the pectoralis, rectus abdominis, and to some slight extent the other abdominal muscles. In the water, with hind quarters extended, the first three of these act as strong extensors of the humerus during propulsive action of the arm. Upon the land all of these muscles operate largely from the opposite end, assisting to the limit of their capabilities in flexing the lumbar region and making of this and the sacrum a sort of substitute femur and shank which the animal can use more expeditiously than it can the two upper segments of the limb proper. This flexure of the posterior vertebrae is used in a variety of ways besides in swimming, as in scratching, of which one can assure himself by watching the contortions of a young otariid at play.

The function of these muscles in the *Phoca* is very different. The panniculus, with fibers running rather evenly cranio-ventrad rather than converging to the axilla, is undoubtedly of assistance in the caterpillarlike mode of terrestrial progression, but it is difficult to see how the other muscles mentioned above can be of great use in such movements. In fact, an analysis of the manner in which the seal travels upon land is rather puzzling, but it is likely that the long back musculature and the psoas complex furnish most of the motive power. The rhythmic lateral movements of the hind flippers employed by these animals as the primary, and indeed sole means of propulsion in swimming have their inception in the middle thorax, as they do in the Cetacea and most fish, while the anterior thorax and the neck in large degree act as a fulcrum. The muscles of the posterior thorax and the lumbar region that are employed in these movements are primarily the enormous sacrospinal muscles, which have become massive in size but of simpler design, and accessory to these the hypaxial musculature or psoas complex. Of secondary but still of definite importance in this connection are also the latissimus dorsi and the posterior half of the pectoralis. They help to pull the posterior end of the body from side to side and operate chiefly from the deltoid crest of the humerus as a fulcrum, while the atlanto-scapularis inferior, humerotrapezius, and perhaps other muscles in conjunction, act as antagonists to prevent humeral movement. As in fish, the apaxial and hypaxial muscles of a single side act as a unit, although there is theoretically nothing to prevent them from operating with equal effectiveness in the sagittal plane as is the case in the Cetacea. The hypaxial muscles act upon the ilium and the leg, while the sacrospinalis or apaxial mass acts chiefly upon the whole pelvis, through its extensive insertion upon the "medial" face of the ilium, turned sharply lateral for just this purpose.

The pelvis of the Otariidae is somewhat weak, while that of the Phocidae is very strong and angular. For somewhat different reasons the innominate bones of these two families have become considerably differentiated in the same general direction from the normal fissiped type of pelvis, chiefly by the trailing position persistently assumed by the limbs. Most of the muscles originating from the anterior ilium are normally rotators of the femur, and as the ilium is long in fissipeds (measured from the acetabulum, 59 per cent of the innominate length in the cat) it must be important that these rotators have a long leverage. Strong rotation of the femur in pinnipeds can be of less use, however, because of the extreme shortness of this bone and the position assumed by the leg. It is true that these muscles do act as rotators of the femur in *Zalophus*, but more as abductors of the femur in *Phoca.* And in neither can the flexors of the femur nor the femoral extensors of the shank have much function as such because of the shortness of the thigh and fixed posture of the leg. All of these details conspire to obviate the need for a long ilium and the result has been an extreme shortening of this part of the innominate (32 per cent of the total length of the bone in *Zalophus* and but 16 per cent in the *Phoca*). In the fissiped the more caudal part of the innominate gives rise chiefly to muscles which extend the femur and flex the shank, and caudad of the acetabulum this portion of the pelvis is 33 per cent of the innominate length in the cat, 55 in *Zalophus*, and 74 in the *Phoca.* In the pinnipeds the whole leg is so bound down that but little extension of the femur or flexion of the shank is possible. In this order, therefore, both these groups of muscles are, by virtue of the trailing position maintained by the legs, as much if not more concerned with the actions of abduction and adduction, which is of especial use to the Phocidae. The farther the innominate extends caudad the longer will be the lever arm of these muscles and hence we find this rearward extension more pronounced in the phocids. In the otariids the pelvic muscles are used for a great variety of movements, none of which is likely of great importance to the animal, but the hind feet are flapped and rotated this way and that in their function of rudders, and the pelvic musculature is correspondingly specialized and split up into numerous divisions—the adductors to as many as six, the sartorius into two, etc. On the other hand the hind feet of *Phoca* are used for but one thing—flapping from side to side—and the musculature is correspondingly specialized, but in the direction of fusion and simplification. The gluteal mass has little to do but act upon the greater trochanter in a way to cause chiefly abduction of the femur, and the pubo-ischial muscles as adductors of the shank, but with some function of elevation and depression according as origin is from the dorsal ischium or the

pubis, and the innominate in this region has corresponding depth to allow for this. These two main movements of the leg—abduction of the thigh and adduction of the shank—are complementary in *Phoca*, for as the plantar surface of one foot is pressed against that of the other during active swimming, adduction of the right femur, for instance, assists abduction of the left shank, and the opposite.

The only other details of the innominate that merit mention consist of the dorsal spine or tuberosity of the ischium in the Phocidae extending well dorsad and developed by the narrow and somewhat tendinous origin of the superficial biceps femoris, which in the Otariidae does not arise from the innominate. Another detail is the tendency in the *Phoca* toward obliteration of the femoral process, and the development in this animal of a distinct and large process upon the ventral border of the ilium for the insertion of the psoas magnus, of such importance in its swimming.

Length of limb, comprising the sum of femur, tibia, and the distance from the tip of the second toe to the posterior border of the astragalar condyle, is without much significance in the Pinnipedia because so much of the limb is within the body. However, as compared to body length this item is 104 per cent in the cat, 62 in *Zalophus*, and 74 in *Phoca*.

The femur in this order has become very short indeed. Whereas this bone in the cat is 35 per cent of the body length, in the *Zalophus* it is but 22 and the *Phoca* 29 per cent. In function it plays a very minor part as a segment of the limb and I regard its diminution in size as intimately correlated with the shortening of the ilium and consequent reduction in the length of the muscles between these two points as well as by the great reduction in femoral mobility. I am not prepared to say that the position of the femur is uniform in the Otariidae, but at least in the *Zalopus* dissected the static position of this bone was apparently at a cranio-lateral inclination forming an angle with the body axis of about 45°, but markedly rotated. In other words, the femur is normally carried very strongly flexed and rotated cranio-mediad. (See fig. 30.) In contrast to this the femur of the *Phoca* was directed a trifle caudad of laterad to the body axis and there was no marked rotation. As a result of these postures the muscles that pull cranio-mediad (the gluteal complex) upon the greater trochanter of the otariid chiefly rotate the femur, with the final result on land of turning the toes outward. This same action in the *Phoca* results in the abduction and extension of the femur. Another result of these femoral positions is that in reality the effective length of the otariid leg is less than the sum of the tibia and pes, while in the phocid it is greater. The arc of effective flexion and extension of the femur seems to be only about 25° in *Zalophus* and 30° in *Phoca*, with the amount of flexion in the former slightly greater

than extension. Abduction and adduction is greater—possibly through as much as 40°.

The flatness of the pinniped femur is probably attributable to a variety of stimuli—the lack of need for antero-posterior thickness, the need for a greater trochanter extending well laterad of the

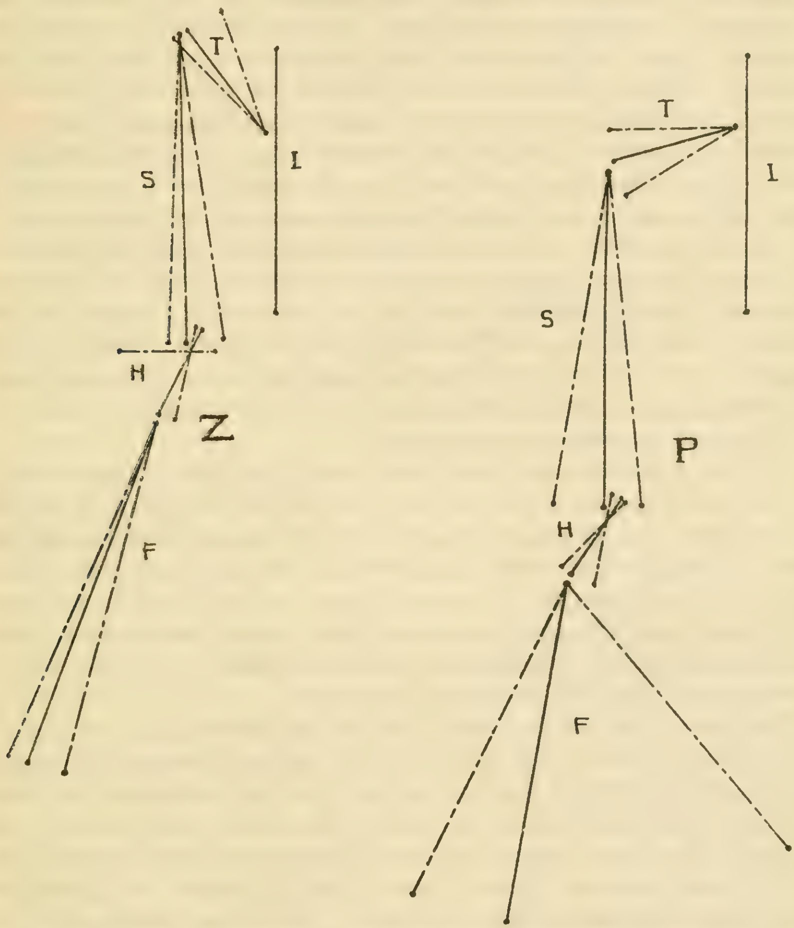

FIG. 30.—DIAGRAM ILLUSTRATING APPROXIMATE STATIC POSTURE (SOLID LINES) AND DEGREE OF POSSIBLE MOVEMENT (BROKEN LINES) IN LIFE OF EACH JOINTED SEGMENT OF THE POSTERIOR LIMBS OF ZALOLPHUS (*Z*) AND PHOCA HISPIDA (*P*). *I*, INNOMINATE; *T*, THIGH; *S*, SHANK; *H*, HEEL (ASTRAGALUS AND CALCANEUM); AND *F*, REMAINDER OF FOOT

acetabulum and for a broad distal extremity. The greater trochanter of both animals is very similar. In the *Zalophus* the trochanteric fossa is a slight concavity while in *Phoca* it is a very deep pit because in this animal the muscles inserting in its vicinity are more specialized in order that all may perform practically the same act and their insertions are more circumscribed and more strictly

tendinous. The lesser trochanter, occurring in the Otariidae only, is rather small and supports narrow insertions of the sixth adductor, pectineus, and psoas magnus and iliacus element. In *Phoca* the only one of these muscles which insert in this vicinity is the pectineus, and this more broadly. The more decided and sharp epicondylar ridges of *Phoca* are doubtless attributable to the stronger action of the muscles originating therefrom. In the skeletons at hand the patellar " fossa " of the otariid is undifferentiated and this part of the femur is convex. In the sea lion dissected the patella also rested at the junction of the thigh with the shank rather than upon the femur, because of the flexed position of the latter bone. In some other members of the Otariidae, however, there is considerable variation in this detail, and I shall not attempt to account for this condition. In the *Phoca* there is a deep, concave patellar fossa in the usual situation. As previously noted, a line passing through the center of the two femoral condyles describes an angle with the axis of the shaft of about 79° in *Zalophus* and 63° in the *Phoca*. This is attributable to the lateral condyle being somewhat more proximad than the medial in the otariid, and much more so in the phocid. This will be discussed in relation to the shank.

The pinniped tibia has experienced some shortening but not nearly to the same degree as the femur. In the cat this bone is 36 per cent of the body length, in the *Zalophus* 22 and in the *Phoca* 29 per cent. From another angle, the femur of the cat is 97 per cent of the tibia length, in the *Zalophus* 50 and in the *Phoca* 40 per cent. The shank is of the usual carnivore type, that of the sea lion rather straight except that the fibula is slightly rotated, and of the phocid more curved, but with the fibula nonrotated.

The head of the tibia differs from that of the ordinary fissiped in having the anterior edge quite sharply angular instead of sloping, which is undoubtedly due to the fact that in pinnipeds the shank is never really extended in respect to the thigh. The head of the fibula in the *Phoca* is even and continuous with the tibial head, but in *Zalophus* it slopes directly distad from the latter and is continuous in this direction with the shaft. This is a provision in the otariid for excessive flexion of the shank in respect to the thigh, the femur fitting down over the sloping head of the fibula in a sharper angle than is mechanically possible in the phocid. As mentioned, the lateral femoral condyle of *Zalophus* is situated a bit more proximad than the medial, but in the markedly flexed static position of the shank the only effect which this condylar position has is to place the shank in a more pronated posture. The lateral tuberosity of the shank in this animal, however, is placed more distad than the medial, and this has the effect, in the position assumed by the limb segments, of elevating the shank and ankle toward the dorsum. The

disparity between the positions of the femoral condyles of *Phoca* is considerably more marked, but in the somewhat more extended position in which the femur of this animal rests this has the same effect of elevating the ankle but to a more marked degree, caused by the more sloping articular head of the shank. This marked elevation of the phocid pes is very characteristic, and I have seen an animal sleeping for an hour or more with the hind feet elevated in a position which to any other mammal would surely be the height of discomfort.

A pinniped peculiarity, or at least one that is not shared by the majority of fissipeds, is found in the knee joint. The medial or tibial collateral ligament is not attached at a point about one-tenth the distance from the knee to the ankle, as in the cat, but at a point in *Zalophus* about two-fifths, and in the *Phoca* about one-quarter, this distance. In connection with a loose capsule of the joint the result is that in the Pinnipedia there is permitted at least 40° of rotation of the shank with respect to the femur (in the partially dissected specimens), the fibular collateral ligament being the pivotal center. This I believe to have been brought about chiefly by the fact that during most of the time the hind feet of both the otariids and phocids are maintained with their axes practically continuous with those of the shanks, and in this position rotational movements of the feet would be transmitted to a considerable extent directly to the knees. In the *Zalophus* only, such rotation of the shank, in the direction of supination, has the effect of adducting the ankle. Flexion and extension of the pinniped shank is largely inhibited, especially in the otariid, by the muscles which bind it down so closely and by the limits of elasticity of the integument in which it is inclosed. These movements are possible through an arc apparently of only about 15° in the *Phoca* and even less in *Zalophus*.

The fibular head of the *Zalophus* is placed more caudad of the shank in respect to the direction of the femoral articulation than is the case with Phoca—almost directly caudad of the lateral tuberosity in the former, and caudo-laterad, at an angle of 45° in the latter. In the phocid the tibia is straight, so that the ankle joint "toes out" to an angle of about 45° to the transverse axis of the proximal articular surface of the shank. In the otariid, however, there is rotation of the fibula so that considered in the same light, the transverse axis of the ankle joint is parallel to that of the knee. This means that were these plantigrade fissipeds, the foot of the *Phoca* would at rest point straight laterad and of the *Zalophus* latero-craniad at about 45°, which in fact it very nearly does. In the *Zalophus* the fibula ends somewhat proximad of the tibia, and the articular surface of the latter is several times the larger. In *Phoca*

these bones end even and the articular surface of the fibula is almost as extensive as of the tibia. *Zalophus* has few malleolar grooves which are broad and shallow, but in *Phoca* these are exceedingly deep, narrow, and pulley-like, which form has undoubtedly been developed by the constant see-saw movements of the tendons performing precisely repeated motions during swimming.

The shank bones, especially the fibula, of *Phoca* are more ridged and show more indications of every kind of strength of muscle. Perhaps the most remarkable muscular modification of this region is without osteological indications, however, and includes the hamstring muscles—biceps femoris, gracilis, semimembranosus, and semitendinosus. In the *Zalophus* the biceps is of a very remarkable rhomboid shape. Insertion of the superficial sheet is fascial over the proximal four-fifths of the shank, and origin is practically as extensive over the anterior caudal spines. The result is that the shank is bound down nearly in contact with the innominate and its mobility is almost inhibited. Equally effective in this function but less strikingly modified are the gracilis, semimembranosus and semitendinosus whose insertions are distributed over the distal two-thirds of the shank, and with origins confined to the posterior part of the innominate. In *Phoca*, whose hind limb is apparently useless for all purposes save lateral oscillations, one would expect the biceps to be even more modified for binding down the shank, but such is not the case. The muscle is of prime importance in adduction of the shank, so although insertion is extensive over the shank (the proximal seven-eighths) for long leverage, the muscle is robust and tapers to a tendinous origin from the superior spine of the ischium, where it can act to good advantage as an adductor, as well as an elevator to some extent. The other hamstring muscles are also strong, and disposed in insertion much as in *Zalophus;* but origin, especially of the anterior semitendinous, is not so entirely confined to the posterior border of the innominate, thus giving a slightly greater length to these muscles. The hamstring group are the only muscles which can adduct the shank with any real power, and hence, are of fundamental importance to the swimming of *Phoca*. They act in the most intimate cooperation with the muscles of the lower back in performing the lateral oscillations of the posterior end, and it must not be forgotten that because of the adpressed palmer position of the feet, adduction of the ankle and foot of one side may furnish much of the impulse to abduct those of the opposite side.

As mentioned elsewhere, there has been a slight movement proximad of the origins of the flexor digitorum longus, and peronei longus and brevis of these pinnipeds, and a movement distad of the origins of the flexor hallucis longus and extensor digitorum longus. The stimuli for these changes are obscure, however. Because the muscles of the

Zalophus were emaciated and those of the *Phoca* very full, little comparison of the strength of the shank muscles could be made. Details of note, however, were the presence in *Phoca* only of a gastrocnemius lateralis and absence of the soleus, and strength of the gastrocnemius medialis and flexor hallucis longus. These differences are, of course, related to variations in foot action, but most of them in an obscure manner.

The effective length of the bony part of the foot, measured from the posterior margin of the astragalar condyle for a cat, is 34, the *Zalophus* 28, and *Phoca* 34 per cent of the body length. Thus the osseous foot of the last has not shrunken in relation to the trunk length as has the rest of the limb, and that of the otariid has done so but slightly. Or from a more likely aspect, the foot of both animals has experienced a secondary increase in size following a very marked, primary decrease in the length of the rest of the limb, especially the femur. This increase of foot length, however, has not been sufficiently rapid in the Otariidae to keep pace with the needs of the animal, and there has been an extension of the digits by means of cartilagenous rods and slightly more circumscribed interdigital membranes. The part of the pes distad of the bones is very flexible and the cartilages are prolonged distad of the interdigital membranes to a degree that seems entirely useless, and one which at present seems very inefficient.

The measurement from the tip of the longest otariid toe (externally) to the border of the astragalar condyle is 36 per cent of the body length, which is the same as in the phocid. In the latter, however, the interdigital membrane extends between the toes in a much more effective manner, and there is no flexibility distad, for there are no cartilagenous extensions of the digits. But the foot is relatively larger than in the otariid, and the measurement from the external toe tip, as above, constitutes the same proportion of the trunk length as in the eared seal. Either the increase in foot size has kept pace with the needs of the animal, or, as seems by no means unlikely, the Phocidae lack the ability so readily to develop digital cartilages.

As with the manus the plantar surface of the otariid is bare and wrinkled, and of the phocids, as well haired as the remainder of the foot. The first and fifth toes of the former animal have minute nails, sunk in pits of the integument, but the nails of the other three digits are long, nearly straight, and very slender, as are those of all five digits of the phocid. The otariid frequently folds back the part of the pes distad of the bones, leaving the three long nails projecting, and with these vigorously scratches all parts of the body. I see no other way in which they could be utilized and agree with F. Wood Jones (1925) that the retention of real nails upon the three

middle digits of the pes in the Otariidae is solely because of this fuction of scratching and combing the hair. I am, however, at somewhat of a loss to explain the retention upon all the digits of the pes in *Phoca* of such long nails. Jones believes that the position of the pes of this animal inhibits any appreciable scratching by the nails, to which I subscribe, and that the limited toilet is then performed by the claws of the manus, in which I do not agree, for any such action by the manus is well nigh as limited as by the pes. And yet it seems that the claws must be of some definite use, for the Phocidae are certainly sufficiently ancient for their claws to have disappeared entirely were they not of practical value to the animal in some respects.

The details of pedal movement are not easily followed either in the reconstructed foot, or from the embalmed specimen after most of the tissue and many of the muscles have been cut away. The ankle joint of *Zalophus* is such that the tibial facet of the astragalus dips but slightly medioventrad from the horizontal, while in *Phoca* it and the fibular facet are both at 45°. The result is that if one hold the shank vertical and bend the foot, the transverse plane of the phocid foot is at practically 90° to the shank, while in the otariid it is nearer 45°. In other words, in such a free limb, disarticulated from the body, the tendency is for merely the lateral border of the foot to rest upon the ground—not the entire sole. The full plantigrade position may be assumed, however, either by forced pronation through the ankle joint and the tarsal articulations, or more likely by the slight adduction of the proximal shank toward a knock-kneed position, the rotation of the shank at the knee joint in a direction toward pronation, and of the femur in a direction toward supination. This is less complicated than it sounds; but the strange part is that could *Phoca* place the sole flat upon the ground in the same fashion as can *Zalophus*, none of this rotation or adduction of the shank and femur would be needed. In the otariid the crotch, or angle between the hind limb and the tail, was at the calcaneal tip, while in the phocid this point was situated some 20 mm. farther distad; so the difference in this respect is not by any means so great as alone to prevent the phocid foot from assuming a plantigrade posture did other anatomical details allow it to do so. Murie (1874) considered that the phocid's " incapacity to use its hind foot on land depends more on the different proportion of femur to leg bones and lowered attachment of integumentary caudal expansion than to absolute difference in the construction of the bones forming the ankle joint"; but none of the three points mentioned are of primary importance in inhibiting such an act.

As already mentioned, the static position of the trailing feet when submerged seems to be with the palms steeply V-shaped in *Zalophus*,

and the opposite in *Phoca;* but adpression of the palms is assumed with ease in both animals, and much pronation and supination is possible from this position. There is but slight pronation or supination through the actual ankle joint of either animal, but the articulations distad are loose and movement much facilitated, especially in the phocid.

In the *Zalophus* the flexion-extension action of the ankle proper is through an arc of about 75° and of the tarsus through 10° or 15°, allowing the foot to assume a plantigrade position or to trail in the same plane with the axis of the shank. In *Phoca*, however, conditions are very different. Movement at the ankle joint is from the extreme trailing position through an arc of only 30° toward plantigradism, the inhibitional factor being the tendon of the flexor hallucis longus, as discussed later. In the oscillating swimming movements of the feet of this animal it is requisite, however, that there be more play and flexibility than such an ankle joint will allow, and this is attained through the articulation between the astragalus-calcaneum and centrale-cuboid. And this joint, called the tarsal joint, is actually more flexible than that of the true ankle, this being through an arc of 65° or more. The result is that the mechanism of the phocid pes is very handlike, and the tarsus may be flexed at a right angle to the axis of the heel, thus assisting by a follow-through movement the adductor motion of the distal leg in swimming. In the otariid the tibial facet of the astragalus is prolonged onto the neck but stops short of the junction with the heel. In the phocid this condition is just reversed, showing that the joint is considerably better fitted for maintaining the foot perpetually in a trailing posture. In the entire specimens, however, there is no appreciable difference in this respect, which is a further instance of the fact that from observation one can not always tell what a structure is best fitted to do.

Comparative osteology is not yet at the point where the significance of slight changes in the interrelationship of the tarsal bones are perfectly understood, and not a great deal can be said with confidence regarding the structure of the otariid tarsus. That of *Phoca*, however, is somewhat more illuminating. The calcaneum, is rather weak but is deeply grooved for the passage of the peroneal tendons. Partly accountable for the lack of strength in the posterior process of this bone is the fact that the phocid has no soleus and that in this animal as well as the *Zalophus* the plantaris is entirely distinct from the "tendo calcaneus" and passes mediad to it. In fact, in view of the permanently extended position of the foot, together with the development of the flexor hallucis longus, one would rather expect to find that this process was still more reduced in the earless seal.

It is, however, in the phocid astragalus that interest chiefly centers. Its articular facets differ from those of *Zalophus* as already discussed, but in addition there extends caudad a large, long process—an accessory heel, as long and almost as deep as that of the calcaneum. It is broadly grooved caudo-ventrad for the passage of the stout tendon of the flexor hallucis longus, and it is the strong tension of this muscle that primarily, if not solely, inhibits the assumption of a plantigrade posture by the foot in this animal. This is, perhaps, the most significant single detail of the specialization of the Phocidae. Why is it that the hallucis longus was so highly and peculiarly developed to flex the foot with a considerable leverage to a somewhat excessive degree rather than the muscles going to the calcaneum, with equal leverage ready to hand is a puzzling circumstance. It is likely, however, that one important factor was that the hallucis, as it occurs in this animal, is also well fitted for facile flexion of the digits. In its distal portion also the astragalus differs much from the condition in *Zalophus*. Whereas in the latter the facet for articulation with the centrale is prominent and highly convex, and with a protuberant process mediad, in the *Phoca* this facet—very much smaller—is flattish and somewhat irregular. In addition, the distal part of the bone is rendered much more narrow by the absence of the medial process, probably caused partly by the more dorsal position in this animal of the tendons of the extensor hallucis and tibialis anticus, and partly by the reduction in width of this part of the tarsus. By the shape of this facet and its relation in regard to the cuboid the excessive amount of movement of which this tarsal joint is found to be capable is evidently facilitated, and the narrowness of the tarsus at this point permits a certain amount of motion in the transverse plane. Another point worth mention is that as the calcaneum and astragalus are of the same length, they can be, and are, closely bound together by ligaments and therefore together constitute an unusually solid base for the remainder of the pes.

The lateral side of the cuboid has a groove for the passage of the peroneus longus tendon that is completely roofed over by a process of the bone in contact with metatarsus 5. These tarsal grooves, absent as such in *Zalophus* and formed exclusively by the peroneal muscles in *Phoca*, are an indication of unusual and persistently recurring contraction of these muscles. In the trailing position in which the feet of this animal are always carried, action of the peroneal group results exclusively, if we except the usual binding action upon the tarsal bones of the peroneus longus, in elevation of the feet, and therefore to some slight degree as an aid to the spreading of the digits. These facts suggest that there is somewhat more of a twisting, sculling movement of the rear flippers in swimming than one is able to distinguish during observation of a live individual.

The proximal ends of the metatarsal bones in both animals seem to have been subjected to transverse pressure, indicating that this part of the foot may be narrower than in the ancestral forms. In *Zalophus* this has resulted in making the metatarsal bases narrower and deeper, but in *Phoca* merely in excessive crowding, with numerous short processes filling all available spaces. A stimulus for this sort of interlocking tarso-metatarsal articulations has probably also been furnished by the fact that the feet of this animal are useless upon land. After removal of the integument it is found that the otariid metatarsus 1 and 2 are bound closely together, while there is a slight amount of transverse play between the others; in the phocid, 1 with 2 and 4 with 5 are so bound, and these, as two units, may be slightly moved transversely from 3. As in the usual land mammal, however, transverse movement of the metatarsals during the spreading of the digits is found to be really very slight.

In both pinnipeds there has been a strengthening and lengthening of the first and fifth digits and their metatarsals which is of decided use in stiffening both borders of the pes while it is expanded and being forced against the water, but this seems to have been carried to a greater extreme in *Zalophus* than can now be of real use. There is a suggestion of flattening of the phalanges, especially upon the plantar aspect in *Zalophus*, and to some extent in all its digits and metatarsals. This is specialization in the expected direction for an aquatic mammal.

There is no especial provision, in the way of arrangement of pedal tendons, for the spreading of the otariid foot and the muscles of the foot proper appear to be quite weak. This is not surprising, but one is mildly astonished to be unable to distinguish any special provision in the phocid either, although the plantar muscles are rather strong. From manipulating the pes, however, it seems that spreading the digits does not in this animal consist of purely transverse impulses, but that this action is slightly oblique and consists very largely of extending the first digit and moderately flexing the fifth at the metatarsal-phalangeal joint only. Thus interrelated action between certain of the flexor and extensor tendons of the digits would supply the activating power for spreading the toes, but the conformation of these tendons does not disclose their identity.

CONCLUSIONS

A discussion of pinniped relationship is of decided secondary importance in the present paper, but it is felt that it is desirable to offer some consideration of this question, as well as some weighing from a phylogenetic viewpoint of the anatomical evidence encountered. The order may be characterized as follows:

PINNIPEDIA

Amphibious mammals of fusiform shape and with short tails. The elbow and knee always well within the body contour and with the feet webbed and paddle-shaped. The digits are always five and the fifth toe of the pes is approxmiately equal to the first, both being greater than the three middle toes. The mammae number either two or four. The incisors in living forms are always fewer than 3/3 and the cheek teeth, variable in number, generally consist of four premolars and one molar, but occasionally there are two or three molars (*Callotaria*). The molariform teeth never have more than two roots and there is no differentiated carnassial tooth, all these teeth being uniform in character. The milk teeth are small and simple and are shed at an early age. The lachrymal bone is almost always absent; when present it is small and within the orbit. The audital bulla is composite. There is no clavicle. The preacetabular length of the innominate is apparently always much less than the postacetabular, at least in living forms. The humerus is massive and the bones of the forearm very broad. The femur is much reduced in length and is flattened. There is an os penis. The brain is large and its convolutions complex. The kidneys are lobulated and in adults there are large hepatic sinuses of the vena cava.[6] There are no Cowper's glands.

OTARIIDAE

External ear small. Both fore and hind feet used extensively during terrestrial locomotion. Area of forefeet great, this extremity being plainly indicated as the more definitely developed for aquatic propulsion, and the axilla is situated at mid forearm. The hind feet assume a plantigrade posture during terrestrial locomotion and the astragalus is without a conspicuous posterior extension. A cartilaginous extension to each digit occurs and the palms and soles are naked. The nails of the forefeet and those of the first and fifth digits of the hind feet are vestigeal. The testes are scrotal in the adult male. The tooth formula is:

$$i.\,\frac{3}{2},\ c.\,\frac{1}{1},\ pm.\,\frac{4}{4},\ m.\,\frac{1\text{ or }2}{1,\ 2,\text{ or }3};$$

total 34 to 38. The canines are but moderately developed. The molariform teeth have a single main cusp and at times a cingulum, with occasionally slightly developed anterior and posterior accessory cusps. The skull has a well-developed postorbital process, normally an alisphenoid canal, a mastoid that is usually noninflated, and a mastoid process that is conspicuous and continuous with the paroccipital

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[6] The presence of these sinuses is merely presumed to be uniform within this order.

process. The ossification of the border of the auditory meatus is regular and uninterrupted in fetuses[7] and the occipital condyles are usually narrow. The vertebral spines of the anterior thorax are well developed. The scapula is subtriangular (never falciform) and with a distinct acromial process. The greater tuberosity of the humerus is higher than the lesser and there is no entepicondylar foramen. The ilium is but slightly curved—not markedly and abruptly bent laterad. The femur has a lesser trochanter.

PHOCIDAE

There is no external ear. Neither fore nor hind feet are used as primary aids in terrestrial locomotion. The area of the forefeet is reduced and the axilla falls opposite the wrist. The external surface of the hind feet is increased, relative to the length of the leg, these being plainly indicated as the chief means of aquatic propulsion rather than the forefeet. The astragalus has a posterior extension as long as that of the calcaneum, and the foot is prevented from assuming a plantigrade posture by the unusual tension of the flexor hallucis longus muscle. There are no cartilaginous prolongations of the digits, and the palms and soles are usually well haired. The nails are well formed and never vestigeal. The testes are abdominal in the adult male. The tooth formula is:

$$i.\ \frac{2 \text{ or } 3}{1 \text{ or } 2},\ c.\ \frac{1}{1},\ pm.\ \frac{4}{4},\ m.\ \frac{0,\ 1 \text{ or } 2}{0,\ 1 \text{ or } 2};$$

total 26 to 38. The canines are rather poorly to moderately developed. The skull has no postorbital process, and there is no alisphenoid canal. The mastoid is relatively inflated and the mastoid process either poorly defined or else not continuous with the paroccipital process. The ossification of the border of the auditory meatus is irregular and interrupted in the fetal state[8] and the occipital condyles are usually broad. The vertebral spines of the anterior thorax are very poorly developed. The scapula is often somewhat falciform and the acromial process is not well marked. The lesser tuberosity of the humerus is usually higher than the greater, and there is often present an entepicondylar foramen. The ilium is markedly and abruptly bent laterad. There is no femoral lesser trochanter.

Many other characters of differentiation exist, but for the most part these are slight and not so well suited for purposes of diagnosis. In addition, a few of the above characters need verification

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[7] In the Otariidae this was determined for *Callorhinus* only, but it is probably a uniform character.

[8] Determined in the case of *Phoca vitulina* only.

regarding their invariable presence in or absence from the two groups before they can be accepted without reservation.

Little account has been taken of the Odobenidae or walruses in the present paper, but it may be mentioned that morphologically they appear to be little more than specialized otariids, distinguishable chiefly by the enormous development of the upper canines (which has been followed by necessary adjustments in the bones of the skull) and compensating reduction in number of the remainder of the teeth, as well as a change in their pattern to conform to special food; disappearance of the external ear, and a change in the limbs, making these in some respects intermediate between those of the Otariidae and Phocidae. There is no doubt whatever that the relationship of the walruses is much nearer to the eared than to the earless seal stem.

Wortman (1894) believed that the Pinnipedia are derived from the Oxyaenidae, a phylum of inadaptive creodonts. Matthew (1909) has argued convincingly against this thesis, and ascribes ancestry to the arctoid fissipeds, but Kellogg (1922) presents evidence which apparently renders the latter as well as the former theory unlikely.

Remains of unquestionable Pinnipedia of both otariid and phocid affinities have been found from the Miocene, but from no deposits of older age, and these remains are of pinnipeds which had already reached a high degree of aquatic specialization. Hence it is certain that this order diverged from terrestrial fissipeds at a very early time. But until far more and considerably older remains of this order than are now available are at hand, any attempt to allocate the pinniped relationship and ancestry is too speculative for acceptance. All that seems certain is that the pinniped precursor was of carnivore stock, with probably some affinities with that large aggregation of diverse predators known as the adaptive creodonts. In view of the profound changes which had already taken place in pinnipeds of the Miocene, the origin of this stock was "probably not later than the Eocene" (Kellogg, 1922) and possibly earlier.

There has been much conjecture regarding the derivation of the pinniped families. Many investigators have considered that the order is diphyletic or biserial, and some (as Mivart, 1885) have favored the theory that the Otariidae are descended from an ursine, and the Phocidae from a lutrine, ancestor, and have presented anatomical data in support of such reasoning; but this is not convincing and evidence of much weight may be marshaled against it. It is hardly necessary to review this question in detail in the present connection, but it has seemed to me rather unprofitable to consider seriously the probable relationship of any family of pinnipeds with any of existing fissipeds. Furthermore, the otariid stock is considered

to be older than the ursine, as mentioned by Kellogg (1922), and the phocid line may well prove to antedate the lutrine.

At any rate the typical otariid is now very different from the typical phocid of the present day. Comparative anatomy should contribute much evidence informative of the degree of phyletic divergence that they have experienced, and it is found to do so, but the evidence is often of so contradictory a character that it is far less satisfactory than had been hoped. The significance of some of the more important of the differences as they exist, however, may be discussed.

The methods of swimming now employed by the otariids and phocids are fundamentally different. These differences may date from the time when the first ancestors of the two families managed to swim across a river, or it is very possible that the ancestral otariid and ancestral phocid followed the same method of swimming until they were as well fitted for aquatic life as, say, the otter (*Lutra*), or conceivably more so. The two stocks then acquired steadily increasing adaptations, but of diverging sorts, throughout the ages, or else one or the other of them experienced retrogressive changes of indeterminate duration. In other words, it is not impossible that there was a considerable stretch of time when the otariid employed also the hind feet and the phocid also the forefeet primarily as accessory propulsive organs, and that this time lasted sufficiently long for strong anatomical evidence of the fact to remain at the present day. And indications, as enumerated shortly, are not lacking that retrogressive changes of this sort may actually have been experienced by both families. Furthermore, it is extremely probable that all parts of the body which show aquatic modifications have not evolved at the same rate or velocity. Thus, the fact that the external ear of the phocid has disappeared while that of the otariid has not may merely indicate that slight differences in habits have operated to retain the external ear in the latter.

As evidence for or against close relationship of the two pinniped stocks such matters as general body form, external details of the eyes, nose, and ears migration distad of the external axilla and of the crotch of the posterior limb and craniad of the anterior border of the pectoralis origin, form of the innominate, and shortening of certain segments of the limb, are not particularly illuminating, for these are items which conform to usual or eventual requirements of aquatic adaptation and they might be due largely to convergence. On the whole, however, *Phoca* exhibits in these respects a somewhat greater divergence from fissiped conditions than does *Zalophus*.

The following differences may be considered as attributable chiefly to the dissimilarity in the modes of progression characteristic of the two families: differences in the form of the neck; in the length

and general form of the manus; in hypaxial and sacrospinal musculature, the latter being largely instrumental in causing differences in the processes of the vertebrae and in the conformation of the ilium; in the diversification of the hip muscles of *Zalophus* and their tendency toward fusion in *Phoca*; the astragalar extension in *Phoca* and peculiarity of the flexor hallucis longus muscle; and of the flexibility of the tarsal joint in *Phoca*.

Differences which I consider might be attributed either to aquatic adaptation of the two sorts shown, or to phylogenetic influences, consist of the dissimilarities exhibited in the occipital musculature, sternomastoid, cephalohumeral, humerotrapezius, rectus abdominis, deltoid, the origin of the triceps longus and of adjoining muscles, the presence of an episubcapularis in *Zalophus* only and of an abductor digiti quinti longus in the *Phoca* only, the differences shown by the humeral tuberosities, the palmaris longus, and the iliacus.

Differences which may be laid chiefly to phylogenetic influences rather than to aquatic adaptation consist of many of the details of the skull, the presence of the complex division of the longus colli in *Zalophus* only, and likely the absence in this genus of the quadratus femoris, and of the presence in *Zalophus* only of the soleus.

Resemblances of a quality which one might reasonably consider to constitute evidence of close relationship comprise some features of the triceps complex, similarity in the migration of attachments of the brachial muscles, broadening of the antibrachial bones, resemblance shown by the deeper division of the biceps femoris, the occurrence of a hepatic venous sinus, and possibly of the details of the tibial collateral ligament and plantaris tendon, and of the presence of a superior division of the atlantoscapularis, although the latter may likely be of little import.

It has been mentioned that dissimilarities in the external ear, mode of swimming, and of terrestrial locomotion may be interpreted as evidence that *Phoca* is the more highly adapted to aquatic life and hence has diverged more from the fissiped type. In contrast to this, the thesis that *Zalophus* is the one that has traveled farther from the typical terrestrial carnivore is supported by the greater tendency toward "telescoping" of its skull, cartilagenous extensions of the digits, the greater tendency toward flattening exhibited by the pedal phalanges of this pinniped, and possibly by the development of the nails.

In scrutinizing the anatomical details encountered there occur a number of questions which are not readily answered, as enumerated below. To these the reader, if he be so minded, may add the query as to why such arm muscles as the triceps and deltoid are so specialized or well developed in *Phoca*. This I am not including for the reason that I am inclined to ascribe this condition to possible

antagonistic work which the brachial muscles of this animal must needs perform during swimming movements by the hinder portion of the body. These questions, then, may be propounded as follows. Given the habits and form of the two animals dissected, then:

1. Why should the crotch of the posterior limb be located practically as far distad in *Zalophus* as in *Phoca?*

2. Why should the superficial division of the biceps femoris be developed in *Zalophus* to bind down the shank more firmly than it does in *Phoca?*

3. Why should the excessively shortened femur be relatively of the same length in both?

4. Why should the pes of *Zalophus* be in most respects more specialized than is *Phoca?*

5. Why should there be such large cartilagenous extensions of the pedal digits in *Zalophus* but none in *Phoca*, which apparently would have more use for them.

If one accept the thesis of a certain amount of retrogressive evolution having taken place then these five points are easily explainable. For the sake of argument then, let us presume that at one time before the Phocidae used the posterior limbs so exclusively for aquatic locomotion they made great use of the forefeet also. The adjoining muscles would then become highly specialized, a condition which might survive as a relic after disuse had caused great reduction in the size of the forelimb. Similarly, then, it may also be argued that the hind limb of *Zalophus* may conceivably have been a primary means of aquatic progression in the very distant past, and it then might readily have acquired the puzzling details listed above, which subsequent relative disuse has failed to obliterate. In support of such argument is the seeming fact that the terminal digital cartilages of the pes of a juvenile *Zalophus* appear to be relatively better developed than in an adult.

This hypothesis of retrogressive evolution has been presented merely because it largely explains matters, and it is the only one which appears to do so. I may eventually come to accept it but at the present time I am, nevertheless, far from convinced that this is the proper explanation.

It is seen that the present contribution sheds little or no light upon the question of whether the Otariidae or the Phocidae is the "older" family. The evidence is conflicting and the proper weight to accord details of variation is, and probably always will be, a moot question. It is felt, however, that this evidence points to the probability that the Otariidae, although not necessarily the better (or as well) equipped for an aquatic existence, have perhaps departed widely from a typical terrestrial condition in more numerous and profound respects than have the Phocidae.

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EXPLANATION OF PLATE

PLATE 1

Mounted skeletons of an eared seal (Otariidae, genus *Callorhinus* below) and an earless seal (Phocidae, genus *Phoca* above) exhibited to show normal terrestrial positions.

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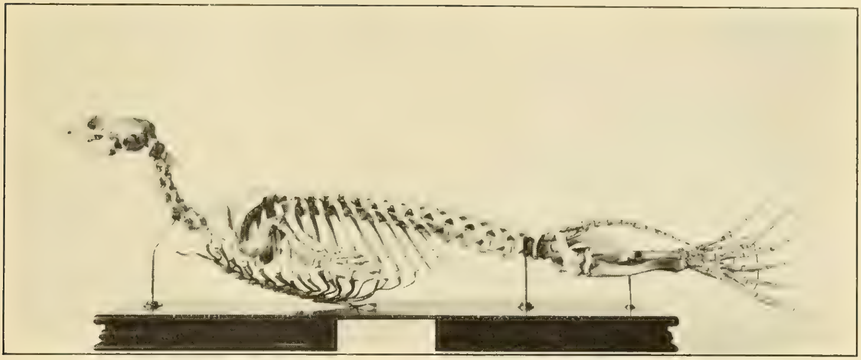

MOUNTED SKELETONS OF AN EARED SEAL (OTARIIDAE, BELOW) AND AN EARLESS SEAL (PHOCIDAE, ABOVE)

FOR EXPLANATION OF PLATE SEE PAGE 142

ZEOLITES FROM RITTER HOT SPRING, GRANT COUNTY, OREGON

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and

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INTRODUCTION

The minerals described in this paper were collected in June, 1915, by D. F. Hewett while engaged in making a geological reconnaissance of a region lying west of the Blue Mountains in Oregon for the United States Geological Survey. Recently a study of the minerals was undertaken by E. V. Shannon, of the United States National Museum, who has done the crystallographic and microscopic work and part of the analyses. The remainder of the analyses were made by Forest A. Gonyer. Even though some of the minerals found are uncommon in the United States and are well developed in this area, the study was first undertaken to throw light on the paragenesis of the zeolites, rather than to investigate the characters of the minerals themselves. The lapse of time between the field study and laboratory investigation leaves some doubt that highly satisfactory conclusions regarding the paragenesis have been reached, though the results seem worthy of presentation.

OCCURRENCE OF THE ZEOLITES

By D. F. Hewett

Surface features.—Ritter Hot Spring lies in sec. 6, T. 8 S., R. 30 E., Willamette meridian, Grant County, on the north side of the Middle Fork of John Day River, and about 45 miles north of John Day on the road from that town to Ukiah, Umatilla County. In this region the three main forks of John Day River flow generally

northwest in narrow valleys that lie from 1,000 to 1,500 feet below the adjacent rolling uplands. Locally the main roads follow the river valleys, but travel northward is difficult. If the spring were more accessible, it could form the basis of a popular resort.

Pre-Tertiary rocks.—The stratified rocks exposed at the surface in the region are Carboniferous and Triassic and include limestones, argillites, and quartzites. These are intruded successively by gabbro, peridotite (now largely altered to serpentine), and several varieties of granite, all of the pre-Cretaceous age.[1] During late Mesozoic time these rocks were extensively eroded, so that the region west of Blue Mountains was reduced to low relief. Doubtless some of these rocks underlie the area near Ritter Hot Spring at no more than 1,000 feet below the surface.

Tertiary rocks.—The rocks of Tertiary age in the region include a wide range of volcanic tuffs and flows separable on lithologic and structural bases into five formations (ascending order): Clarno and John Day formations, Columbia River basalt, and Mascall and Rattlesnake formations.[2] Ten miles east of Ritter the Columbia River basalt rests on pre-Cretaceous altered gabbro, but 30 miles west the other Tertiary beds attain a maximum thickness of 5,000 feet. Only the Columbia River basalt flows and associated scoria outcrop near Ritter, and probably none of the earlier Tertiary rocks separate the basalt from the underlying pre-Cretaceous rocks.

The Columbia River basalt is well exposed on the walls of the Canyon of the Middle Fork of John Day River, which is 1,300 feet deep at Ritter. This thickness is made up of many flows, each of which displays a dense columnar phase overlain by vesicular phase and more or less scoria. The columnar phase is dark greenish black, but the vesicular phase and scoria are mingled dark green and brick red. Most of the flows range from 50 to 125 feet in thickness. In the small area shown in Figure 1 only three flows are exposed, a partial section of which is given below:

Section of Columbia River basalt at Ritter Hot Spring, Oreg.

		Thickness
Upper flow, vesicular and scoria phases.		
Upper flow, columnar phase	feet	15–20
Middle flow, vesicular phase	do	30–40
Middle flow, columnar phase	do	15–25
Lower flow, vesicular and scoria phases	do	50
Lower flow, columnar phase.		

[1] Lindgren, W., The Gold Belt of the Blue Mountains of Oregon: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 2, pp. 561–776, 1901.

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[2] Merriam, J. C., A contribution to the geology of the John Day Basin: Univ. of California, Dept. of Geol., Bull., vol. 2, pp. 269–314, 1901.

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The basalt has not been studied microscopically, but doubtless its mineral make-up is that generally characteristic of the rock in northern Oregon.

Although the basalt flows appear to be nearly horizontal over a large area, observations made during this investigation indicate that

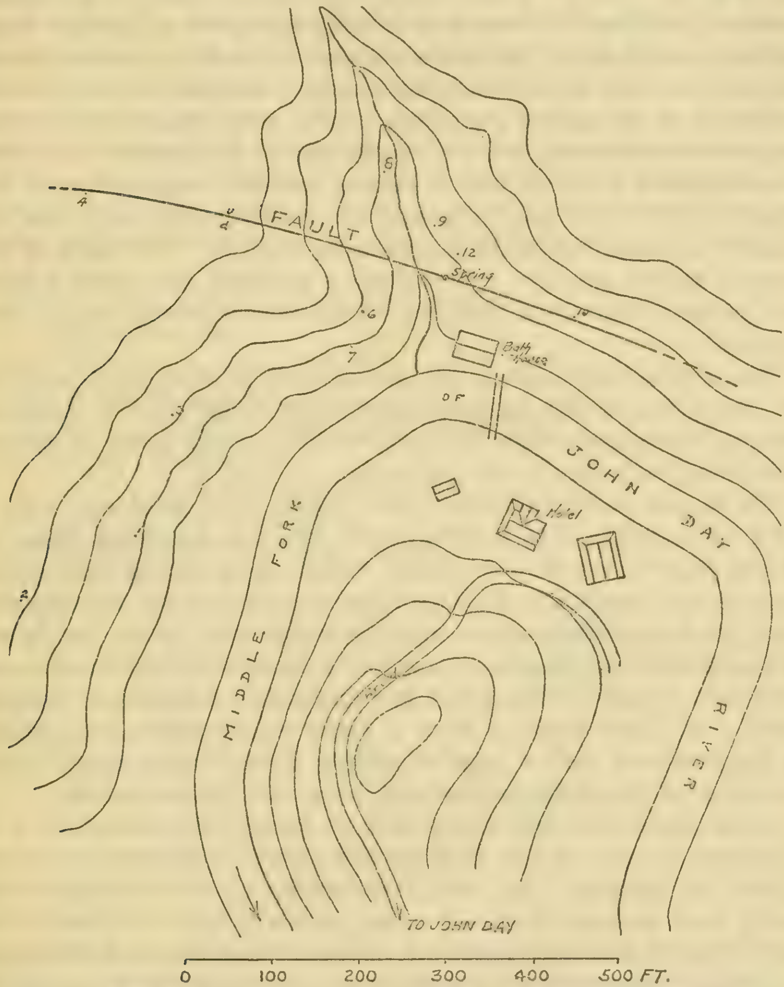

FIG. 1.—SKETCH MAP OF RITTER HOT SPRING AREA, GRANT COUNTY, OREG. CONTOUR INTERVAL APPROXIMATING 20 FEET

there are a number of gentle anticlines which trend northwest, and a few faults of small displacement roughly parallel to the anticlines. Ritter lies near the crest of a gentle anticline that plunges northwest, and the spring issues from a fault that trends north of west, along which the flows on the south side have dropped about 20 feet.

No intrusive rocks younger than the Columbia River basalt were noted in the region. In the Blue Mountains the only late Tertiary intrusive rocks noted [3] were dikes of olivine basalt.

Hot springs.—So far as the writer could learn in the region, the only hot springs known on the upper parts of the John Day River are at Ritter and that which lies in sec. 15, T. 13 S., R. 30 E., 3 miles northeast of Mount Vernon and 32 miles due south of Ritter. Only the first was visited. The present outlet of the Ritter spring lies on the fault referred to, 32 feet above the river and 100 feet north of it. Doubtless in an earlier period the outlet was higher but has been progressively lowered as the river has carved its channel. The flow was estimated at 35 gallons a minute and the temperature at the outlet is 110° F. A few bubbles of gas rise from the outlet and the odor of hydrogen sulphide is noticeable near by. The taste of the water is mildly alkaline. No analysis is available but where it flows over rocks it deposits a thin film of calcium carbonate and a little sulphur.

The zeolites described in the second part of this paper occur in two ways, (1) on the line of fault referred to and (2) in the vesicular and scoriaceous phase of the lower flow. Only traces of zeolites were noted in the two overlying flows.

The fissure is separable into three parts. The southwest part is filled with stilbite, 4 to 6 inches wide, which is separated from the central part by 7 feet of unaltered basalt. The central part shows, in succession beginning at the southwest wall, a layer of stilbite as much as three-fourths of an inch thick (pl. 2*b*), which locally envelops angular fragments of calcite; a layer of scalenohedrons of clear pale yellow calcite, 4 to 6 inches thick; a layer of arborescent calcite 1 to 3 feet thick; a layer of clear yellow calcite, and, finally, on the northeast wall a layer of stilbite, 2 to 6 inches thick. Here the order of deposition appears to be calcite, stilbite, calcite.

In the scoria over the lowest flow, at locality 12, analcite is most abundant in area 10 feet in diameter. Here good crystals rest on a layer of mesolite. (Pl. 2*a*.) At locality 9 some vesicles in the scoria show scalenohedrons of calcite overlain by rhombs of chabazite, which in turn are overlain by fibers of mesolite, and others are completely filled with fibrous mesolite. At locality 8 fragments of scoria are covered with a layer of thomsonite one-fourth inch thick. (Pl. 1*c*.) This mineral is abundant here but was not noted elsewhere. Near by, veinlets in the flow show (1) a layer of mesolite, (2) rhombs of calcite, (3) milky opal which fills the remaining voids. Opal was not observed elsewhere. South of the fissure, at locality 6, in the upper part of the vesicular zone of the lowest flow,

[3] Pardee, J. T., and Hewett, D. F., Geology and mineral resources of the Sumpter quadrangle: Oregon Bur. of Mines and Geology, vol. 1, p. 45, 1914.

there are separate vesicles filled with calcite, with chabazite, and with mesolite. Others show analcite on chabazite, and still others, stilbite on chabazite. Near by, at locality 7, there are vesicles filled respectively with calcite and chabazite as well as others showing the following succession: Calcite, chabazite, pseudomesolite, and stilbite. At locality 1 some of the vesicles near the top of the lowest flow are filled with calcite, others with chabazite, and still others with mesolite. At locality 2 some of the vesicles at the top of the middle flow are filled with chabazite; others show crusts of mesolite on calcite.

Paragenesis—In many places near the spring, as noted above, certain zeolites occur in abundance but not associated with other zeolites. There are summarized below the order of deposition of the zeolites and other minerals where two or more are associated and their relations are clear, the numbers indicating the localities shown on the map.

1. Chabazite, mesolite (or pseudomesolite).
2. Calcite, mesolite.
6*a*. Chabazite, analcite.
6*b*. Chabazite, stilbite.
7. Calcite, chabazite, pseudomesolite, stilbite.
8. Mesolite, calcite, opal.
9*a*. Calcite, chabazite, pseudomesolite.
9*b*. Mesolite, pseudomesolite.
10 (fissure). Calcite, stilbite, calcite.
12. Mesolite, analcite.

From this summary it is clear that there is not a simple order of deposition for the entire area in which each mineral appears but once. On the other hand, if the minerals of the fissure be ignored the simplest succession indicated is as follows:

1. Calcite ($CaCO_3$).
2. Chabazite ($CaO.Al_2O_3.4\ SiO_2.6H_2O$).
3. Mesolite ($[CaO, Na_2O].Al_2O_3.3\ SiO_2.3H_2O$).
4. Pseudomesolite ($[CaO, Na_2O].Al_2O_3.3\ SiO_2.3\ H_2O$).
5. Analcite ($Na_2O.Al_2O_3.4\ SiO_2.2\ H_2O$).
6. Stilbite ($CaO.Al_2O_3.6\ SiO_2.6\ H_2O$).
7. Opal (SiO_2+H_2O).

This sequence does not take into account thomsonite which, though abundant in one locality, is not associated with another zeolite. It would seem that in the area outside of the fissure there was a tendency for the least siliceous minerals to be deposited first and the most siliceous last. Unfortunately, the fissure contains but two minerals, one of which, calcite, is repeated, and the sequence does not confirm the conclusion stated above.

Genesis.—The association of the zeolite-bearing areas, the fault fissure and the active hot spring indicate a genetic relation between them. The age of the fault is obscure, but it was probably formed

in late Pliocene or early Pleistocene time. No intrusive rocks of assured late Pliocene or Pleistocene age are known in the region, so that no close connection between the hot spring and intrusive rocks can be shown. Doubtless the hot spring once reached the surface several hundred feet or even more above its present outlet and the zeolites were deposited by it. An attractive hypothesis assumes that the minerals with increasing silica content were deposited during a period of rising temperature of the waters and that the final calcite in the fissure represents the latest mineral of the cooling stage.

DESCRIPTION OF THE MINERALS

By Earl V. Shannon and Forest A. Gonyer

DIABANTITE

In many of the specimens the first lining of the amygdaloidal cavities consists of a very thin layer of deep olive green to greenish-black material, of waxy appearance and dull luster, which resembles a clay mineral. This dark mineral preceded the zeolites in all cases where it occurs and lines some vesicles which contain no other mineral. The layer is seldom more than a fraction of a millimeter in thickness, and the material is not present in amount sufficient for analysis. The thickest crust of it observed lined the small cavity containing the zeolite described as levynite. Under the microscope the dark mineral shows a micaceous, aggregated structure and consists of small plates either interwoven or arranged in fan-shaped groups and spherulites. It has fairly high birefringence and greenish-yellow color. Plates on edge show parallel extinction with faint plechroism in greenish brown parallel to the fibers and brownish green across the plates. The elongation is positive. No interference figure could be obtained, but since plates lying on the base are dark in all positions between crossed nicols it is believed that the axial angle is near zero and the mineral optically negative. The refractive index is variable, but the mean index of most of the grains is between 1.590 and 1.600.

Though this mineral resembles some of the high-iron varieties of the clay mineral beidellite, the optical properties are somewhat nearer the chlorites diabantite and delessite, which are commonly formed in amygdaloidal cavities of basic igneous rocks in association with zeolites.

LEVYNITE ?

A single small specimen of a white glassy zeolite not in amount sufficient for analysis could not be satisfactorily identified, although it may, wholly or in part, consist of levynite. The properties obtained for this mineral are somewhat contradictory and its positive identification must await the finding of additional material.

The specimen is contained in a piece of greenish, rather coarsely crystalline basalt which appears fresh and unaltered, and contains a few sparsely scattered vesicles of nearly spherical form. The smaller of these are empty except the thin lining referred to diabantite. The largest cavity, however, nearly 2 centimeters across, contains a thicker layer of diabantite, and a filling of tabular crystals of the white zeolite. The crystals are transparent, colorless, and are as much as 1 millimeter thick by 8 millimeters broad. Though the centers are glassy and transparent there is a narrow border, visible where the crystals are broken, [across] which parallels the basal faces and is whiter, less transparent and has a cross-fibrous silky appearance.

When the crystals are crushed and examined in powder under the microscope, grains broken across the plates show the border to have a cross-striated appearance and higher birefringence than the cores, although the border is continuous with the central part and uniform with it in extinction. Many grains show basal cleavage and a striped appearance suggesting the polysynthetic twinning in a plagioclase. Although the optical properties are variable and confusing, a majority of the grains seem to be optically positive (+) with 2V small, marked dispersion $r<v$, and the indices of refraction $\alpha=1.489$, $\beta=1.491$, $\gamma=1.494$, all ± 0.002.

A tabular crystal selected from the specimen and embedded in an oil of index 1.490 appeared homogeneous and dark between crossed nicols. It was uniaxial and negative with the optic axis perpendicular to the basal face. The index $\varpi=1.493\pm 0.002$. These features agree with the optical properties of levynite.

Although the uniaxial character, if coinciding with the external form would indicate a hexagonal or tetragonal mineral—and the specimen looks like the tabular forms of the minerals of the chabazite group—this symmetry could not be confirmed. The crystals are not suited for crystallographic study. A single very unsatisfactory crystal which gave a few approximate measurements on the goniometer had faces of what appeared to be two pyramids with rho (ρ) angles of 45° and 58° approximately and with phi (ϕ) angles 45° apart. These appeared hemimorphic and twinned on the basal plane. Edingtonite is the only zeolite belonging to such a symmetry class and the mineral is certainly not edingtonite.

If collectors visit the locality and make extensive collections, sufficient material of this character will probably be found to permit a complete investigation. Until then its identity must remain in doubt.

CALCITE

Calcite is widespread but is neither abundant nor of unusual character or quality in the Oregon collection. It occurs as rhom-

bohedral crystals of poor luster and imperfect form as the first deposit in cavities containing later mesolite, pseudomesolite and stilbite. In other very similar specimens the calcite has steep scalenohedral form. The dense fibrous mesolite crust closely coats the calcite and, when broken away preserves perfect molds of the calcite crystals. Some of these molds are 4 or 5 centimeters on an edge. The calcite is colorless to pale brownish and when broken shows brilliant cleavage surfaces. In a lot of specimens which contain broad crusts of stilbite such rhombohedral crystals of calcite occur both under and above the stilbite crust in such manner as to indicate that the calcite is of two generations.

Another small lot of calcite specimens consists of arborescent masses of very small, steep rhombohedra aggregated in parallel position. The calcite is white except where stained by soil or algae. The only associated mineral is pseudomesolite in scattered cottony tufts resting upon and evidently later than the calcite.

HEULANDITE

In the specimens in which thomsonite occurs as crusts lining large open spaces in a slaggy, often highly vesicular and altered basalt, the smaller cavities, up to 5 millimeters across, are lined with a crust about 0.5 millimeter thick of opaque-looking white crystals of another mineral. Most of the smaller cavities have open centers but a few of them have a solid central filling of bladed thomsonite. The symmetry of the white crystals could not be made out. Some of them look like chabazite twins, others look like small trapezohedra of analcite, and still others suggest portions of complex phillipsite-like twins. Although lustrous without, these crystals are porous within and somewhat skeletal as though partly dissolved out. Frequently the crust rests on a thin layer of waxy greenish clay. When the white crystals are crushed and examined under the microscope the grains lie on a perfect cleavage face which is perpendicular to the acute bisectrix. The mineral is biaxial and positive, with 2V small to medium. An occasional grain shows a dividing line on either side of which the mineral differs in extinction showing that the crystals are more or less sectored. The index of refraction, β, is 1.500.

These optical properties are in close agreement with heulandite although the mineral looks unlike heulandite in the specimen. The material is granular and finely aggregated making optical measurements difficult. It seems probable that this is heulandite which is secondary and pseudomorphous after some other zeolite, possibly harmotome or phillipsite. Careful qualitative tests gave negative results for potassium and barium. In age relations this pseudomorphous heulandite is known to be younger than the greenish clay mineral and older than the thomsonite.

Normal heulandite occurs in the collection under discussion but rarely and as very thin crusts or druses lining amygdules. This heulandite was seen to be overlain by stilbite and chabazite in different specimens. Since the mineral preceded chabazite it was deposited very early in the series and is probably the oldest of the zeolites now found in the specimens. The little crystals have the usual form and are colorless and glassy with pearly luster on the (010) face.

MESOLITE

Two minerals which are conspicuous in a considerable number of the specimens of the Ritter Hot Springs collection occur in intimate relation to each other; are very similar in their fibrous structure and appearance; and, as shown by analysis of carefully selected and optically proven samples, are practically identical in composition. Nevertheless these two minerals are sharply distinguished from each other optically and it has been necessary to consider them as two distinct minerals. One seems quite certainly to be mesolite of normal character. The other is described below as pseudomesolite, although it presents some small differences from the material described by Winchell under that name.

The analyzed sample of mesolite is the cast of the interior of a cavity about 5 centimeters across and similar in character to the specimen illustrated. (Pl. 1*b*.) The first deposit in this cavity was calcite in crude, nearly colorless rhombohedra up to 2 centimeters across. Upon the calcite crystals lies a layer of compact fibrous zeolite which for the first 3 to 5 millimeters has a silky luster and dense texture. Beyond this zone the fibers diverge, are free, and are stained brownish. Entangled in the free fibers and penetrated by them are rude crystals of stilbite averaging 3 by 5 millimeters in size. None of the minerals completely lined the cavity and in different parts of the specimen either calcite, the fibrous material, or stilbite may rest against the wall.

Optical study proves that there are two distinct minerals included in the fibrous material. The densest compact-fibrous material shows a moderately low birefringence and finely fibrous, nearly parallel structure, and though there is a suggestion of slightly inclined extinction, it could not be proven owing to the small inclination and the low birefringence. The elongation of the fibers is Y and their apparent elongation therefore changes from positive to negative alternately as they are rolled between crossed nicols under the gypsum plate. The mean of refraction index, β, is about 1.517 ± 0.002 (variable). Aggregates of fibers give, when in a position to show maximum birefringence, a confused figure probably of the obtuse bisectrix with negative elongation, whereas those in position to give lowest birefringence have positive elongation. These

features would seem to indicate a biaxial positive mineral with 2V small and, assuming the direction of elongation to be parallel to the c axis, $c=Y$. Except in that the index of refraction is approximately 0.01 higher, the optical properties of the mineral agree with those given for mesolite in Larsen's tables.[4]

At a sharp line about 3 millimeters from the base of the zeolite layer it becomes more glassy, coarser, and quickly diverges into free fibers. Under the microscope these fibers differ from the more compact material in having lower birefringence and slightly lower index of refraction, β being about 1.512 ± 0.002, with the birefringence approaching 0°. The elongation of these free fibers is Z, and they are positive in all positions—an easy method of distinguishing them from mesolite. The optical properties of the mineral agree with those of okenite but, as shown by analysis of a sample from another specimen having identical optical properties, the composition is identical with that of mesolite. This mineral is described below as pseudomesolite. Each of the free needles of this specimen has a narrow border of a distinct, undetermined mineral of high birefringence, higher indices of refraction, and positive elongation.

The calcite breaks cleanly away from the other minerals, leaving rhombic molds in the mesolite crust. As it was impossible to separate the two fibrous zeolites by hand picking, they were crushed together, screened between 40 and 100 mesh sieves, and run several times through bromoform-methylene iodide heavy solution. The sample thus prepared consisted almost entirely of the pure material of Y elongation, here called mesolite, with only a very little of the material of Z elongation, here referred to as pseudomesolite. This sample was analyzed with the following results:

Analysis and ratios of fibrous mesolite

Constituent:	Per cent	Ratios		
SiO_2	42.02	0.697	0.697	0.92×3
Al_2O_3	28.94	.283	.283	1.12×1
CaO	10.46	.187	.270	1.07×1
MgO	.06	.001		
Na_2O	3.24	.052		
K_2O	1.92	.020		
H_2O above 125° C	13.20	.732	.768	1.02×3
H_2O below 125° C	.64	.036		
	100.48			

These results give the mesolite formula commonly adopted with

$$(Ca,Na_2)O.Al_2O_3.3SiO_2.3H_2O.$$

The ratio between Ca and Na_2 is nearly 2:1, so that the formula may be expanded to

$$2CaO.Na_2O.3Al_2O_3.9SiO_2.9H_2O.$$

[4] Esper S. Larsen. Optical determination of the nonopaque minerals: U. S. Geol. Survey Bull. 679, p. 208, 1921.

In the specimens at hand the mesolite is confined to one lot and is neither so abundant nor so varied in habit and associations as pseudomesolite. The specimen illustrated in Plate 1 is very similar to the one from which material for analysis was taken. In the illustrated specimen the broad crude crystals of calcite are coated with a compact layer of the white mesolite about 2 millimeters thick, consisting mainly of fibers with elongation Y and an index of refraction of about 1.520. Mixed with this is more or less material with the optical properties of the pseudomesolite. The central part of the specimen is a cavity loosely filled with free fibers of pseudomesolite with almost zero birefringence, positive elongation, and an index of 1.510. These fibers also have a narrow border of some mineral of high birefringence and higher refractive indices. Much of the mesolite appears to be in polysynthetic twins.

Other specimens show mesolite in fibrous masses, the fibers up to 1 centimeter long, radiating from sharp scalenohedral crystals of calcite, and terminating in free fibrous crystals in the cavities. The fibrous crystals are truncated by a bright basal plane, but it was found impossible to obtain any signals from them on the goniometer. One specimen shows considerable amounts of chabazite, in colorless masses with only a suggestion of crystal form, which is believed to have been deposited later than the mesolite. Adjacent small amygdules are filled with granular chabazite and contain none of the fibrous zeolites. Another specimen has the two fibrous zeolites overlain by a considerable amount of stilbite. In this specimen the zeolites preserve molds of rhombohedral calcite crystals 5 centimeters on an edge.

The mesolite is soluble in 1:1 hydrochloric acid and gelatinizes.

PSEUDOMESOLITE

As stated above under the description of mesolite there occurs intimately intergrown with that mineral in some specimens a second fibrous zeolite distinguished by distinctly lower birefringence, slightly lower index of refraction, and positive elongation, for which the name pseudomesolite is here used. The two minerals may be readily identified by the difference in index of refraction when immersed in an oil of index 1.515. The difference in specific gravity of the two minerals is sufficient to permit satisfactory separation with heavy solutions, the mesolite being the heavier, owing perhaps to its denser and more compact texture. The birefringence of pseudomesolite is extremely low and the thinner fibers are almost invisible between crossed nicols. The free fibers loosely occupy cavities in the mesolite specimens, as shown in the specimen illustrated in Plate 1. The pseudomesolite occurs in parallel position as a continuation of

the mesolite fibers and is older than the stilbite of the same specimens. It was found impossible to obtain pseudomesolite from the specimens of mesolite in pure enough form for analysis.

A second group of specimens of pseudomesolite consists of somewhat slaggy basalt coated with broad crusts of loose-textured fibrous white material a centimeter or more thick, and containing in this loose-textured fibrous material numerous more or less perfect trapezohedral crystals of analcite a centimeter or so in diameter. Optical examination showed the fibrous zeolite to be identical with the pseudomesolite associated with mesolite, but entirely free from mesolite. By avoiding the analcite and by scraping the best material from the specimens, a sample pure enough for analysis was secured. Under the microscope it had almost zero birefringence, positive elongation, an extinction not measurable owing to extremely low birefringence, and mean index of refraction 1.510 ± 0.002. The material is easily soluble in hot 1:1 hydrochloric acid and gelatinizes. The analysis gave the following results:

Analysis and ratios of pseudomesolite

Constituent:	Per cent		Ratios	
SiO_2	43.80		0.726	0.242×3
Al_2O_3	28.20		.276	$.276 \times 1$
CaO	10.48	0.187	.256	$.256 \times 1$
MgO	.04	.001		
K_2O	1.46	.016		
Na_2O	3.22	.052		
H_2O above 120° C	13.24	.735	.737	$.246 \times 3$
H_2O below 120° C	.32	.002		
	100.76			

The analysis shows the material to be identical in composition with mesolite, the only difference being in the optical properties. For this reason it is designated pseudomesolite; a name was applied by A. N. Winchell [5] to a zeolite of similar composition found in the anorthosite of Carlton Peak, Minn. Pseudomesolite of Winchell differs from normal mesolite in optical properties, being positive in elongation, with an index of 1.5 and birefringence of 0.002. It has inclined extinction up to 20°. Owing to the thinness of the fibers here described and their very low birefringence no inclination of extinction could be detected.

A third mode of occurrence is in the form of tufts on thomsonite or, in one case, calcite.

By its position in several different types of association the pseudomesolite is shown to be older than analcite and younger than thomsonite, mesolite, and calcite. It is more abundant and more widely distributed than mesolite in the specimens from Ritter Hot Spring.

[5] Amer. Geologist, vol. 26, p. 275, 1910.

THOMSONITE

The most abundant and, in some respects the most attractive mineral from the locality is thomsonite. This zeolite, comparatively uncommon elsewhere in the United States, makes up the larger part of the specimens collected, and in form and appearance is somewhat unlike the thomsonite from any other American locality. Its characteristic mode of occurrence here is as the lining of amygdaloid cavities, often several inches across, as shown in Plate 1*c*. The lining itself is seldom more than 4 millimeters thick and consists of radiating blades of snowy color and pearly luster, which terminate in the surface of the crust as chisel-shaped groups of dull, lusterless knife edges, without definite crystal form and often soiled and dirty.

The thomsonite is usually a more or less solitary mineral. It rests upon a very thin skin of a whitish zeolite described under heulandite. Very rarely there rest upon the thomsonite fine cottony tufts of fibers of pseudomesolite. In one set of specimens the thomsonite layer rests on a thin layer of chabazite and is overlain by crystals of stilbite.

The matrix of the thomsonite specimens is a slaggy basaltic lava which, as already stated, is highly porous and vesicular. The smaller vesicles are lined only with a thin skin of supposed heulandite although an occasional one is filled solidly with thomsonite blades. Much of the matrix basalt is altered to greenish clayey material which is quite soft when moist.

The specimen which was analyzed was purified as far as possible by cracking up and hand picking the pearly fragments of the crust. The fragments were then crushed and screened between 60 and 100 mesh sieves, and run several times through a bromoform-carbon tetrachloride heavy solution. The resultant sample was apparently pure and all of the same specific gravity. The analysis gave the following results:

Analysis of thomsonite

Constituent:	Per cent	Ratios				
SiO_2	37.84	0.630	0.630	0.630	0.315×2	1.01×2
Al_2O_3	31.72	.311	.311	.311	.311×1	1.00×1
CaO	12.20	.218 }	.239 }	.316	.316×1	1.00×1
MgO	.84	.021 }				
Na_2O	4.08	.066 }	.077 }			
K_2O	.96	.011 }				
H_2O above 110° C.	12.56 }	.726	.726	.726	.290×$\frac{5}{2}$	.93×$\frac{5}{2}$
H_2O below 110° C.	.52 }				.363×2	1.17×2
	100.72					

The results agree very well with the formula for thomsonite given by Dana, which is $(Na_2,Ca)O.Al_2O_3.2SiO_2.2\frac{1}{2}H_2O.$, the ratio $Ca:Na_2$ being 3:1. The composition calculated from this formula is: SiO_2, 37.0; Al_2O_3, 31.4; CaO, 12.9; Na_2O, 4.8; H_2O, 13.9=100.0.

There has been considerable discussion for some time regarding the composition of thomsonite.[6] It was hoped that the present material might throw some new light upon this problem, but optical examination proved the sample analyzed to have little value for this purpose.

Under the microscope the grains of the sample all lie on a perfect cleavage plane and show two other cleavages at right angles to this and to each other. Dana makes the perfect cleavage of thomsonite *b*(010) with *a*(100) less perfect and *c*(001) in traces. The elongation is parallel to the *c* axis. All of the grains lying on the perfect (010) cleavage show an excellent biaxial positive interference figure, with the axial plane across the laths or parallel to the plane *c*(001), and the acute bisectrix Z perpendicular to (010). In an oil of index 1.525, however, the sample is found to be slightly inhomogeneous in index. A part of the grains lying on (010) cleavage have a small axial angle and strong dispersion $r<v$ with the refractive indices: $\alpha=1.522$, $\beta=1.524$. Another part of the grains has a little higher birefringence when lying on this plane, slightly larger axial angle, and the indices: $\alpha=1.526$, $\beta=1.529$, $\gamma=1.533$. The dispersion and optical orientation are the same in both and it is evident that the sample consists of two varieties of thomsonite differing slightly in composition. There seems, however, to be no graduation in indices between these two and they are so similar in specific gravity that repeated attempts to separate them by the use of heavy solutions were unsuccessful. Most of the free grains were composed of a single one of the varieties but a coarser sample which was examined showed an occasional core of the variety of lowest indices bordered by later growths of the material of higher indices.

Aggregates of plates occasionally lie on the less perfect *a*(100) cleavage. These are groups of slightly divergent individuals grown together approximately parallel to (010). They show brilliant interference colors and essentially parallel extinction. Such groups give the gamma (γ) index across the length and show the emergence of the obtuse bisectrix. They also show negative elongation, whereas the elongation of blades lying on (010) is positive. The laths may be rolled between crossed nicols and the change of elongation observed with the gypsum plate.

The collection contains one thomsonite specimen of somewhat different type. This is an irregular mass which represents a completely

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[6] S. G. Gordon. Calciothomsonite from Franklin, N. J. Proc. Acad. Nat. Sci. Phila., vol. 75, pp. 273–274, 1923.

E. T. Wherry. Note on the composition of thomsonite. Amer. Min., vol. 8, p. 121, 1923.

S. G. Gordon. The composition of thomsonite. Proc. Acad. Nat. Sci. Phila., vol. 76, pp. 103–107, 1924.

A. N. Winchell. The composition of thomsonite. Amer. Mineralogist, vol. 10, pp. 90–97, 1925.

filled cavity about 4 centimeters across. The material is white and pearly in luster, with a fine, confused, platy-massive structure. Embedded in the massive material, especially near or attached to the wall, are rosettes 6 to 8 millimeters across composed of radiating blades. The rosettes when crushed give laths lying on a perfect cleavage with two other cleavages bounding the grains. These have elongation Y with the acute bisectrix normal to the perfect cleavage; are optically positive (+) with 2V medium, dispersion $r<v$ strong; indices $\alpha=1.525$, $\beta=1.527$, $\gamma=1.530$. This is unquestionably thomsonite like the higher index material of the analyzed sample. The fine, platy-massive material which makes up the solid filling of the cavity shows the same optical characters: Elongation Y, Biaxial positive (+), 2V medium, $\alpha=1.522$, $\beta=1.525$, $\gamma=1.529$. This mineral is also thomsonite.

STILBITE

Stilbite is rather common and forms attractive specimens, some of considerable size, as that illustrated in the lower photograph of Plate 2. In the specimens of this group the only associated mineral is calcite in large, dirty-white cleavage fragments and rhombohedral crystals. These are found both above and below the stilbite crust, indicating two generations of this mineral. The stilbite forms crusts averaging nearly 10 millimeters thick, made up of divergent blades of pearly to silky luster and of white color where unstained. The surfaces of the crusts have vitreous luster and are made up of large numbers of minute crystal terminations, averaging 0.5 millimeter in size, aggregated in nearly parallel position in rounded groups 5 or 6 millimeters across. The principal crystal face is the pinacoid $c(001)$ of the position of Goldschmidt, modified by sharp and lustrous pyramid faces. The stilbite crusts are more or less stained by iron or soil. The sample for analysis was carefully selected from the cleanest fragments of such a crust. When ground and screened between 80 and 200 mesh sieves and examined under the microscope, it was found to be ideally pure. It was composed of elongate laths lying on the most perfect cleavage and bounded on the sides by a less perfect cleavage. The grains lying on the best cleavage give an interference figure indicating the emergence of the obtuse bisectrix perpendicular to this plane, with negative elongation, and with the optic axial plane parallel with the length. If, as usually considered, the best cleavage is parallel to $b(010)$ and the elongation of the crystals is vertical, the orientation is $X=c$, $Y=a$, and $Z=b$. In stilbite Y is usually b, and it therefore seems probable that in the present specimens the orientation is normal crystallographically and optically, but the a cleavage is unusually well developed. All grains show sensibly parallel extinction. The indices of refraction are

$\alpha=1.488$, $\beta=1.498$, $\gamma=1.500$; birefringence=0.012. The analysis gave the following results:

Analysis and ratios of stilbite

Constituent:	Per cent	Ratios		
SiO_2	56. 24	0. 933	0. 933	0. 155×6
Al_2O_3	17. 16		. 168	. 168×1
CaO	8. 56	. 153	. 166	. 166×1
MgO	. 40	. 010		
K_2O	. 32	. 003		
Na_2O	Trace.	-----		
$H_2O+120°$ C	16. 80	. 933	. 986	. 164×6
$H_2O-120°$ C	. 96	. 053		
	100. 44			

The composition is that of an ordinary stilbite represented by the formula:

$$CaO.Al_2O_3.6SiO_2.6H_2O.$$

Another group of stilbite-bearing specimens is that containing mesolite. The stilbite occurs as white crystals up to 1 by 3 by 5 millimeters, entangled in the loose fibers of the pseudomesolite or as loose aggregates occupying the center of the cavity. The stilbite is the youngest mineral in these specimens. The crystals have the usual form—tabular parallel to *b* (010), with pearly luster on the broad pinacoid, and terminated by a rude pyramid. They are aggregates, tending toward a sheaf form, of small individuals not quite in parallel position. Some small specimens show these irregular crystal aggregates, or sheaf-like crystals, alone filling narrow seams up to 1 centimeter wide. Another specimen shows them resting upon a thin crust of white rhombohedral crystals of chabazite and in another they rest upon a thin druse of tiny heulandites.

One lot of thomsonite specimens, containing cavities of considerable size and irregular form, contains small stilbite crystals. The inner crust forming the lining of the cavity is made up of a thin layer of minute rhombs of chabazite averaging 0.25 millimeter in size. Upon this rest hemispherical masses of radiating blades of thomsonite 2 millimeters thick. The surface of the thomsonite is covered with small variously oriented, stilbite crystals of the usual form and about 1 millimeter long. These are perfect and show the pyramidal termination with no basal plane. In places, especially in the smaller cavities of the specimens, the thomsonite is lacking and the stilbite rests directly on the chabazite layer. Under the microscope these crystals of stilbite lie on the flat side, which is perpendicular to the optic normal or Y. They are very beautiful objects and show brilliant interference colors. At the position of maximum extinction, especially in convergent light, they show strikingly the complex hour-glass structure illustrated in Figure 4, under stilbite, in Dana's mineralogy.

ANALCITE

Analcite forms normal trapezohedral crystals up to 1 centimeter in diameter in a number of specimens, invariably in association with pseudomesolite. The two minerals seem to have grown almost simultaneously, although the analcite is slightly later in age. One of the best specimens is shown in natural size in the upper illustration of Plate 2. In this specimen the mode of occurrence in an irregular cavity in highly vesicular lava can be seen to advantage. The associated acicular crystals and fibrous material are pseudomesolite. Sometimes these two minerals rest upon the basalt itself but in most cases they are preceded by a thin skin of chabazite. In the hand specimen the analcite crystals range from grayish and translucent to white and opaque, the difference depending on the quantity of included pseudomesolite.

The sample for analysis was prepared by cracking up selected large crystals, of which the cleanest and most glassy-translucent fragments were picked out, ground, screened between 80 and 200 mesh sieves, and purified as far as possible with heavy solutions.

Under the microscope the analyzed sample was composed of clear grains which showed no cleavage, were uniformly birefringent in low-order gray with grating structure, and give a biaxial negative (−) figure with 2V small and dispersion weak, $r<v$. The mean index of refraction is 1.488. All of the grains show a few penetrating fibers of pseudomesolite but the amount of this is not sufficient to affect the analytical results seriously. Upon analysis this sample gave the following results and ratios:

Analysis and ratios of analcite

Constituent:	Per cent		Ratios	
SiO_2	53. 92	0. 893	0. 893	0. 223×4
Al_2O_3	24. 69	. 243	. 243	. 243×1
CaO	. 96	. 017		
MgO	. 04	. 001	. 204	. 204×1
K_2O	2. 24	. 024		
Na_2O	10. 04	. 162		
H_2O+110° C	8. 62	. 479	. 479	. 239×2
H_2O−110° C	None.			
	100. 51			

These results approximate as closely as usual the formula

$$Na_2O.Al_2O_3.4SiO_2.2H_2O$$

which is the formula given by Dana. The material is thus normal analcite and presents no unusual features.

CHABAZITE

Chabazite appears in numerous specimens, but in very few is it conspicuous. Its most common mode of occurrence is as tiny white

rhombohedral crystals lining cavities beneath crusts of other zeolites. The larger rhombohedra reach extreme dimensions of 1.5 centimeters. A typical specimen is illustrated in Plate 1*a*. The faces of the larger crystals are usually ribbed or striated parallel to the rhombohedral edges, the striae meeting in a line which is the shorter diagonal of the face. The chabazite in some specimens rests against the rock of the cavity wall, but more often it has a thin layer of diabantite between it and the wall, and in one specimen a layer of small heulandite crystals lies beneath the chabazite.

The analyzed sample was prepared from the largest crystal of the lot, which was about 1.5 centimeters on an edge. This was broken up and the best pieces were selected, ground, and sized between 80 and 200 mesh sieves. Under the microscope it was found to be ideally pure, consisting of irregular transparent fragments of very low birefringence, with index of refraction of 1.488±0.002. It was biaxial positive with 2V about 30°. The analysis gave the following results:

Analysis and ratios of chabazite

Constituent:	Per cent		Ratios	
SiO_2	47.56	0.789	0.789	0.197×4
Al_2O^3	20.40	.200	.200	.200×1
CaO	10.52	.188		
MgO	.20	.005	.208	.208×1
K_2O	.92	.010		
Na_2O	.32	.005		
H_2O+120° C	16.28	.903	1.094	.182×6
H_2O−120° C	3.44	.191		
	99.64			

The results agree fairly well with the general formula given by Dana, $CaO.Al_2O_3.4SiO_26H_2O$. The alkalies are rather low, but the mineral is apparently normal chabazite presenting no unusual features.

EXPLANATION OF PLATES

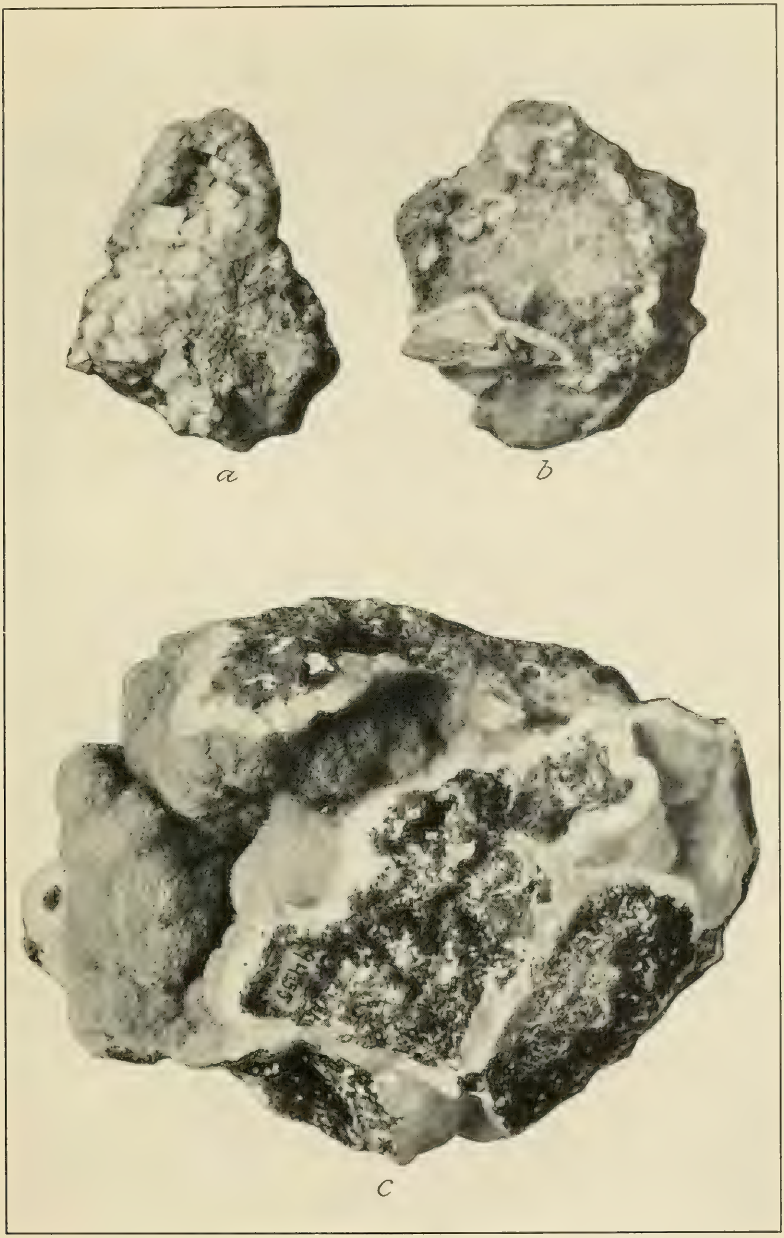
Plate 1

a, Chabazite; *b*, mesolite and pseudomesolite; and *c*, thomsonite

Plate 2

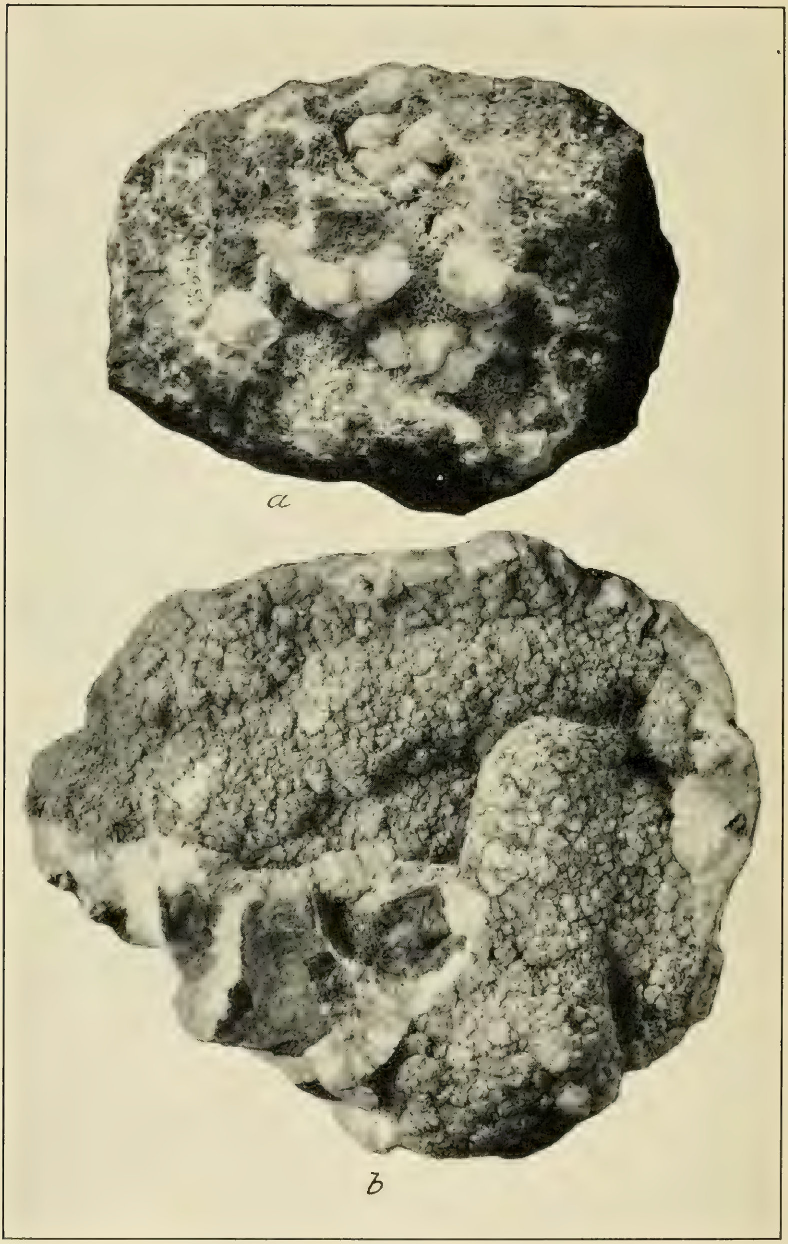
a, Pseudomesolite and analcite, and *b*, stilbite

○



a, CHABAZITE, *b*, MESOLITE AND PSEUDOMESOLITE, AND *c*, THOMSONITE

FOR EXPLANATION OF PLATE SEE PAGE 18



a, PSEUDOMESOLITE AND ANALCITE, AND *b*, STILBITE

FOR EXPLANATION OF PLATE SEE PAGE 18

FIELD NOTES ON VERTEBRATES COLLECTED BY THE SMITHSONIAN-CHRYSLER EAST AFRICAN EXPEDITION OF 1926

By Arthur Loveridge,

Of the Museum of Comparative Zoölogy, Cambridge, Mass.

In 1926 an expedition to secure live animals for the United States National Zoological Park at Washington was made possible through the generosity of Mr. Walter Chrysler.

Dr. W. M. Mann, the director of the Zoological Park, has already published a report on the trip;[1] the following observations were made by the present writer, who was in charge of the base camp at Dodoma during three and a half of the four months that the expedition was in the field.

The personnel of the party consisted of Dr. W. M. Mann, leader of the expedition; F. G. Carnochan, zoologist; Stephen Haweis, artist; Charles Charlton, photographer; and the writer. Several local hunters assisted the party in the field for longer or shorter periods, and Mr. Le Mesurier operated the Chrysler car.

The expedition landed at Dar es Salaam, capital and chief port of entry for Tanganyika Territory (late German East Africa), on Thursday, May 6, and left on the following Monday by train for Dodoma, which had been selected as headquarters. The expedition sailed from Dar es Salaam on September 9.

Dodoma is situated on the Central Railway almost exactly one-third of the distance between the coast and Lake Tanganyika. It was primarily selected as being a tsetse-free area and therefore a cattle country where milk in abundance could be obtained for the young animals; it is also the center of a region unusually free from stock diseases. Secondly, it fulfilled a necessary condition in not being too far from the coast, and while animals could be brought in on the railway from east or west, an automobile road running north and south permitted our tapping the game areas in those directions also.

[1] Smithsonian Misc. Coll., vol. 78. No. 7, pp. 10–21, Apr. 21, 1927.

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Using the Central Railway from Dar es Salaam to Kigoma for purposes of orientation, the localities which were drawn upon for the zoological park may be conveniently listed as follows:

Arusha, 200 miles north, almost due north of Dodoma on Central Railway.

Bahi, on Central Railway, west of Nzingi station. Approximately 3,600 feet.

Dodoma, on Central Railway, about 260 miles inland from Dar es Salaam; 3,700 feet.

Ikikuyu, 90 miles southeast of Dodoma.

Irazo, a village near Dodoma.

Kibakwe, 80 miles southeast of Dodoma.

Kifukulo, a village said to be eight hours' walk from Dodoma.

Kikombo, on Central Railway, first station east of Dodoma; 3,500 feet.

Kikuyu, a village 1 mile from Dodoma.

Kilamatinde, about 10 miles south of Saranda station on the Central Railway.

Kilosa, on Central Railway, 160 miles inland from Dar es Salaam.

Kiva mtango, a village near Dodoma.

Kizumbi, in Shinyanga subdistrict north of Tabora, on the Central Railway.

Kondoa Irangi, 105 miles due north of Dodoma. Capital of Kondoa district.

Kongonda, a village 9 miles from Dodoma.

Malenga, a village near Dodoma.

Manyoni, on Central Railway, west of Saranda station. Altitude, 4,000 feet.

Mbulu, a subdistrict of the Arusha district north of Dodoma.

Mfilima, a village near Dodoma.

Mkata Plains, crossed by the Central Railway, 140 to 150 miles from Dar es Salaam.

Msanga, a village near Dodoma.

Mtangalala, a village near Dodoma.

Mtita's, a chief's village near Dodoma.

Mukwese, about 10 miles north of Manyoni station on the Central Railway.

Nzingi, first station west of Dodoma on Central Railway. About 3,600 feet altitude.

Ruaha, a river flowing through the territory south of Dodoma.

Saranda, a station on the Central Railway with an approximate altitude of 3,000 feet.

Shinyanga, on the new Tabora-Mwanza branch line of the Central Railway.

Singida, capital of a district northwest of Mukwese.

Tabora, on the Central Railway, 530 miles from Dar es Salaam.

Tindi, in Shinyanga district; that is, due north from Tabora.

Tulo, south of the Central Railway at a point about 120 miles from Dar es Salaam.

Zanzibar, an island 40 miles northwest of Dar es Salaam.

The Dodoma district is for the most part a very arid region. This is particularly the case with regard to Dodoma itself, situated in a sandy, thorn-bush area whose flat monotony is only relieved by rocky kopjes which form centers for mammalian life, particularly for the larger carnivora, such as leopards and hyenas.

The resident population are essentially a pastoral people, devoted to their herds of cattle and goats and sufficiently opulent to be somewhat indifferent to augmenting their income by capturing wild animals. Nevertheless, the bulk of the collection, more particularly the birds, was secured by these people, who came in from all the villages within a day's walk of the township.

The chief tribe inhabiting the Dodoma district are the Wagogo, whose origin is somewhat obscure and still a matter of debate among ethnologists. As already indicated, their wealth consists of flocks and herds; in these they invest any money they derive from other sources and the natural increase of the animals constitutes the interest on their investment. In times past they protected their herds from attacks by lion and leopard but to-day they not unnaturally look to the Government to destroy such creatures for them.

They appear to cultivate a minimum amount of maize, rice, or other cereal and thus through the failure of a rainy season, having no reserves, they may be plunged into famine. In the past their herds have suffered from the same cause. One of the functions of government is to anticipate such seasons and have a supply of food on hand.

Around their cultivated plots, locally called "shambas," they make a fence of piled-up thorn bushes to keep out the ungulates, which would otherwise make short work of any produce. Unfortunately the hedges provide a refuge for a rat (*Arvicanthis abyssinicus neumanni*) which makes its burrows beneath them in comparative security. The wily dikdik also often manages to creep through the defense, and the custom is prevalent in some parts to leave gaps at intervals in the hedge with a deadfall set above it. As a tribe the Wagogo are poachers rather than hunters; their favorite method for securing game is to dig pits on game trails or to scare the animals over ground where they have prepared concealed pits.

They are adepts at snaring birds and as a result guinea fowl are scarce near large centers like Dodoma. It is not to be wondered at that young herdsmen, with time hanging heavy on their hands, occupy themselves in setting snares. A more serious cause for the disappear-

ance of game is the probability that these people find a large proportion of the freshly dropped young of dikdik, duiker, and other game animals. If these are habitually taken for the small amount of meat they afford, the extermination of the game in the grazing areas is only a matter of time. In one sense there is no justification for such slaughter, as they have plenty of available meat in their own herds; the same argument, however, applies with even greater force to the European sportsman, and one can scarcely blame the native for not wishing to draw on his small bank account (in the shape of his herd) when he can obtain a variety of diet without doing so.

The huts of the Wagogo are usually built around three sides of a square, the fourth being stockaded and provided with an entrance which is closed at night after the cattle are driven in. Owing perhaps to the difficulty of obtaining tall poles in sufficient quantities, these huts are very low, and it is quite impossible to stand up in them. The roofs are flat or slightly sloping and covered with sods of earth plastered with cow dung; upon them the stock of "mahikwi" is kept; this is a pumpkin plant that grows in their gardens. Occasionally a hungry lion will spring on the roof and from thence into the central yard where the cattle are kept. Then he is shot, while upon his kill, with poisoned arrows fired from chinks or loopholes in the wattle-and-daub inner walls of the huts.

The Wagogo are skillful in the construction of spears, arrows, shields, swords, and scabbards, and show an interesting taste in ornamental beadwork, such as belts, armlets, and collars, each with a different, if somewhat crude, pattern. It is commonly said that they never wash, the application of rancid fat serving the purpose of keeping the skin supple and in good condition. However that may be, they are not an attractive people in the eyes of most Europeans. This is not solely on account of their appearance by any means; in part it is on account of their unsatisfactory behavior as workmen. Though they may apply for work they have no conception of steady application; their traditions and upbringing render them unsuitable as a race for anything but herding and veterinary occupations. Occasionally one hears of an Mgogo personal servant; such a one has generally been trained at a mission station.

In the days of the early explorers and before the country was opened up the Wagogo had a reputation for being truculent; each petty chief, foreshadowing the modern customs system, made demands for largesse before the traveler was allowed to pass through his little district.

Very different are the tribes to the west and east. The Wanyimwezi, whose capital town is Tabora, are notoriously willing workers, and parties of them used to make the long journey to Zanzibar in early times to seek for work as carriers. As a people they are more

fearless of snakes than most, while a cult of their tribe, called the Wayeye, are professional performers with those reptiles of whose attributes and habits they possess a strange mixture of ignorance and knowledge.

The Wakami, with headquarters at Morogoro, or rather in the mountains behind, are a sturdy hill people, cultivating a great deal of maize and eating little meat. The only reason for including their native names for some of the animals was because three Wakami were with the expedition, and the opportunity appeared good to record what they called the animals.

A few Kiswahili names are added; the Waswahili, being a town-dwelling coastal people, do not live very near to nature, and it is only one Swahili here and there that is a reliable informant. Even then the names they apply to most of the smaller creatures are generic rather than specific; they have not, for example, a different name for each species of rat—two or three do duty for all.

Though I have appended the Chigogo names for reptiles, they are of doubtful value without further checking, as species are apt to be confused. They were furnished by a committee of 12 or more old Wagogo men.

These notes do not purport to deal with the whole collection, being mainly concerned with those animals taken in Dodoma district or which were under my charge at Dodoma for a considerable time.

The only new vertebrates secured have been described elsewhere.[2]

Measurements, where skins were preserved, are by my native collector Ramazan. They are given in the following order: Length of head and body; tail without terminal hairs; hind foot without claws but with hoof; ears.

Besides the parasites mentioned under their respective hosts, two hippoboscid flies (*Hippobosca equina*) were taken on native keepers at Dodoma at different times, and another *Ornitheza metallica* Schiner on a weaver bird (species not determined) collected at Dodoma, August 4, 1926.

My grateful thanks are due to the following specialists for identifying material submitted to them and mentioned in these pages: Gerrit S. Miller, jr., such mammals as are marked with an asterisk; Dr. Charles W. Richmond, such birds as are marked with an asterisk; Dr. H. E. Ewing, parasitic fleas; Dr. E. A. Chapin, parasitic ticks; Dr. J. H. Sandground, parasitic worms; Dr. J. M. Aldrich, parasitic flies; and Dr. H. Friedmann, for revising and bringing up to date some of the nomenclature of aves. Also Mr. A.V. Hartnoll, the district administrative officer at Dodoma, for supplying me with the altitudes

[2] Miller, 1927, A new Pedetes from Tanganyika Territory, Proc. Bio. Soc., Wash., vol. 40, pp. 113-114, and Loveridge, 1928, Description of a new species of gecko from Tanganyika Territory., Proc. U. S. Nat. Mus. vol. 72, art. 24, pp. 1-2.

given in the preceding pages and many other kindnesses while at Dodoma; Mr. F. G. Carnochan, for the photograph of the finch lark's nest which he took for me; and Mr. R. H. Rockwell, for his excellent photographs of Dodoma and scenes in the vicinity.

MAMMALIA

CERCOPITHECUS PYGERYTHRUS JOHNSTONI Pocock

JOHNSTON'S GUENON

Native names.—Njadengwa (Chigogo); Tumbili (Kiswahili).

More than 60 of these monkeys were brought in from around Dodoma, Saranda, Kilamatinde, Manyoni, and Kondoa Irangi. Most of them were trapped in the natives' gardens. The "njadengwa" are inordinately fond of the three principal products of the district—namely, "mtama" (millet), maize, and "mahikwi" (pumpkin). They also like "kundi" (beans), groundnuts, and the green tops of potatoes. Papaw and bananas were occasionally given as a luxury.

Feeding them, therefore, presented few difficulties; the usual procedure was to give them milk at 8 in the morning; the administration of this was a tedious business, as the bowl had to be held while each individual drank; otherwise they scuffled and upset it, though not so invariably as the baboons did.

At 9 in the morning a plate of boiled rice was put in every cage and at noon a maize cob or "mtama" head was issued to each monkey to while away the long hours of the afternoon. Water was taken round between 4 and 5 in the afternoon, and then the evening meal, of cooked, ground maize mixed with "kundi" was put into the cages.

Deaths were rare and such as occurred were attributable to injuries inflicted on the animals by their captors or to fighting among themselves. They are very pugnacious as a race and one individual will bite a piece clean out of another or half sever a tail. Temperamentally, however, they vary as much as human beings and when caught young and kindly treated they prove docile and affectionate, for a time at least.

One half-grown monkey, purchased at Manyoni, was notorious for attacking everybody as well as his companions, and was only finally reduced to order by being confined with an old male twice his size, to whom he paid every respect. In reality, his attitude was servile in the extreme. To see him sit quietly while the older animal fed was a revelation to those who had known him foremost in grabbing every tidbit and menacing any other monkey who approached.

One evening when passing the cages I noticed a row of monkeys on a perch. The end one suddenly seized his neighbor and bit him in the shoulder; the latter seized a tail—not that of his aggressor—and gave it a bite. The owner of the tail, with his eyes on me, grabbed at the

tail of the next in the row and bit it, almost mechanically it seemed to me. The whole incident might perhaps be attributed to the boredom of captivity.

In the custom's shed at Dar es Salaam two of the animals escaped; the native keepers wished to give chase, but the possibility of capture was so remote that I ordered them to desist. At feeding time both monkeys returned and were readily secured as they sat on the cages that had so lately been their prisons.

The species was also seen at Nzingi, 6 miles west of Dodoma.

PAPIO CYNOCEPHALUS (Linnaeus)

YELLOW BABOON

Native names.—Mhuma (Chigogo); Nyani (Kiswahili).

Six specimens, said to have been taken in the neighborhood, were brought in to our base camp at Dodoma. The dietary supplied these animals in no way differed from that enumerated for Johnston's guenon, except that a dead bird would occasionally be given to one of the older animals, by whom it would be eaten.

None of our captives were much more than half grown, while one was so young when received in May that it must have been less than a fortnight old. Its black hair gave place to the tawny coat of the adult during the first three months of its captivity. When it was received we already had a pair of yellow baboons wearing belts to which cords were attached. The baby, which screeched without ceasing, awoke the maternal instincts of the young female, which promptly adopted it, and the spidery-limbed youngster might be seen clinging around her at most hours of the day. She was very considerate in allowing it to drink first and in many other ways. After awhile she found the clinging weight growing burdensome and probably uncomfortably warm, and so tried to "wean" it of its attachment. If it left her to eat (it was not chained up), she would, by adroitly skipping this way and that, avoid it, and our nerves would be harrowed by the most ear-splitting screams from the infant until she relented and cuddled it to her bosom once more.

The young male had been obtained from an Indian who kept it chained to a pole in his yard. It had been the butt of boys who had teased it into a very nasty temper from which I imagined it would never recover. About this time it effected many escapes by biting through its cord or biting the person who was leading it from its sleeping place. It generally ascended to the roof or led the chase away toward the village. These escapades resulted in much waste of time, so a large cage was prepared for the reception of the three baboons.

In passing, I might mention a most useful arrangement in this cage, which was the idea of Stephen Haweis. The cage was a large pack-

ing case and was horizontally divided by two narrow planks running lengthwise, onto which were nailed two other planks at right angles. This not only nearly doubled the seating capacity of the cage but left nine spaces through which the animals could play "follow my leader" and other riotous games, which they did with a will. To start the fun it was only necessary for a baboon on the "ground floor" to jerk, as if it were a bell rope, the tail of one of its companions sitting above; the summons was soon answered.

The effect on the young one of being confined in a cage was remarkable; it left its adopted parent for a separate existence and was first with its mouth into any plate of food put into the cage. The stepmother now assumed a different rôle of guardian angel. Sitting on the scaffolding above, she would reach down and seize the youngster by the hair of his head, gently lift him to her, pull open his mouth and feel around it with her finger till she extracted the food, which she would sniff at and then put into her own mouth, allowing him to return to his meal. The serious air with which she performed these ludicrous actions was intensely funny.

The young male also became very tame and docile, so that if one pushed a finger through the wire netting he would take it in his mouth and bite it very gently, letting it remain in his mouth indefinitely. The female had the same little trick, which was soon adopted by the infant. At first she resented this by immediately seizing the "child" and cuddling it to her bosom as she retreated to the back of the cage. During August her attitude changed. If the youngster took anyone's finger in his mouth—and he became most forward of all in doing so—she would quickly push him aside and bite the finger very fiercely, so that I learned to withdraw it promptly as soon as I saw she had observed the intrigue.

Another of their customs after they had been fondling each other was for her to let her tongue hang out of her mouth until he gently took it up in his.

Five other baboons shared the cage of the trio during the last month, but whatever disagreements arose the adopted infant was never molested and his sleek condition and rounded paunch spoke well for the way in which the foster mother exercised her guardianship.

One other baboon deserves special mention. She was more than half grown when brought in by a native; her right ear had been bored to carry a little red twine. I should like to have seen more of her master, for though he parted from her for a comparatively paltry sum her behavior emphasized the extraordinary kindness with which she had been treated. One had but to hold out one's arms and she would spring into them, hugging one to the accompaniment of little crooning sounds or "urrs" of satisfaction. She gave us to understand

that first evening that she would not be shut in a cage. She pointed the argument by biting, at first gently then more severely, and she escaped three times within the hour. Thereafter we allowed her to have her own way and be kept on a chain. At night she slept in an empty room and cuddled a good-natured monkey who also disliked cage life. She escaped many times but caused no anxiety, for when menaced by strangers, or when anyone threw things at her, she would at once rush to the arms of any member of the staff.

When a number of guinea fowl escaped one day with consequent running and shouting, she climbed up a slender telegraph pole and, sitting on the top, surveyed the scene with the greatest interest. Another day we were just starting off in the car when she rose from the veranda and ran toward us, holding out her arms appealingly as she stood almost erect on her hind legs. It was too human and there was nothing to be done but take her in on the front seat. She appeared to enjoy the change and passing objects with almost as much interest as is shown by a dog under similar conditions.

She indulged in the usual simian pastime of fur or skin cleansing in one's hair and it was no unusual sight to see little Indian girls lying on the veranda while she cleaned their tresses with great solemnity; at other times it would be the policeman on duty who would have his fez removed by her and his wool subjected to the same close scrutiny.

PAPIO NEUMANNI Matschie

OLIVE BABOON

Native names.—Mhuma (Chigogo); Nyani (Kiswahili).

Formerly very common at Dodoma, these animals are decidedly scarcer on the kopjes in the immediate vicinity of the town, so much so that I never saw or heard one during the three months I was at Dodoma, though I came on fresh spoor 6 miles east and had the sleeping place of a small troop pointed out to me. The food given to those which were brought in from Kondoa Irangi was similar to that supplied to the yellow baboons. The young olive baboons seemed more quarrelsome and peevish than the former.

GALAGO GARNETTII (Ogilby)

ZANZIBAR LEMUR

Native name.—Komba (Kiswahili). Does not occur in Ugogo.

Undoubtedly the most delightful creature in the collection was a young lemur which I purchased in the streets of Zanzibar on the outward voyage. It grew rapidly and on the eve of embarkation had a beautiful thick coat which it kept immaculately clean; its tail was not so heavily furred. It was very fond of milk and drank half a glass daily; its staple food was papaw, but it was not as fond of

other things to the same extent as some Pangani lemurs which I have known. Sweet things in general it liked, particularly cake, but was not at all keen on meat, either raw or cooked. Its chief delight was to be let out of its cage, when it progressed across the floor by the funniest little jumps of the long hind limbs until it reached furniture, when it sprang from one article to another with astonishing energy and was tireless in its activity. While it slept a good deal during the day it was always ready to come out to play or be carried around. Its bite could draw blood but was usually only given in friendliness. It was quite tolerant of *G. sennaariensis* confined in the same cage.

GALAGO PANGANIENSIS (Matschie)

PANGANI LEMUR

Native name.—Komba (Kiswahili). Does not occur in Ugogo.

A three-quarter grown lemur was sent in from Kondoa Irangi early in August. It remained in its sleeping box during the day and never showed itself till about an hour after dark, when it might be interrupted feeding. While milk and papaw were its principal food, it was generally given raw minced meat, which was relished. A second specimen purchased by Doctor Mann in Dar es Salaam bit through its cord and escaped at Dodoma. Largest male, 170. 270. 60. 40 mm.

GALAGO SENNAARIENSIS Lesson

SENNAAR LEMUR

Native name.—Ndele (Chigogo).

A dozen individuals were brought in, about half at Kondoa Irangi, the remainder at Dodoma. Another was captured by my collector at Saranda, where silhouetted against the moonlight I used to see them springing gracefully about in the mimosa thorn. They are very difficult to keep, as milk and papaw seem to be the only things they will eat besides bananas, and the latter were often unobtainable. The papaw appeared to induce diarrhea. Bread, meat, prunes (raw or cooked), rice, and jellies were all rejected and left untouched. They also appeared to be quarrelsome, for several were bitten on the nose or tail by their companions. At least two were killed in this way.

CHAEREPHON LIMBATUS (Peters)

FREE-TAILED BAT

Native names.—Ibudibudi (Chigogo); Popo (Kiswahili).

A male, 50. 40. 21. 14. 130 mm., was found one morning on the veranda of Kilamatinde boma.

*LAVIA FRONS REX Miller

YELLOW WINGED BAT

One from Saranda.

*HIPPOSIDEROS RUBER (Noack)

RED NOSE-LEAF BAT

One from Saranda.

*EPTESICUS Species

One taken in a lighted room at Saranda.

*PACHYURA LIXA AEQUATORIA Heller

MUSK SHREW

One from Dodoma.

ATELERIX HINDEI SOTIKAE (Heller)

SOTIK WHITE-BELLIED HEDGEHOG

Native names.—Sejesi (Chigogo); Kalunguyeye (Kiswahili).

Individually an excellent pet, socially a villain; these attractive little animals are so fond of milk and minced meat that they will feed immediately after capture, but either a craving for fresh blood or some innate ferocity causes them to eat each other's feet. It would seem necessary, therefore, to keep them separately or in pairs, any crowding resulting in fatalities.

While a few of our specimens were quite definitely caught near Dodoma, the majority came from Kondoa Irangi, where they are very abundant. Two very young ones received from that locality, on August 26, 1926, only measured: Male, 80. 10. 16. 10 mm.; female, 85. 10. 15. 10 mm.

PARAXERUS OCHRACEUS OCHRACEUS (Huet)

OLIVE SQUIRREL

Native names.—Tanji (Chigogo); Panya ya miti (Kiswahili).

Members of this genus, as noted elsewhere make delightful pets if secured young. Most of the expedition's specimens were caught as adults and all came from the vicinity of Dodoma, where they occur in the dense scrub which clothes the larger kopjes.

Their needs are simple, a branch, a gourd, some cobs of maize, a small tin of milk, a piece of papaw or pumpkin, a chicken bone with some cooked meat left upon it—on these they will thrive. One performed a Catherine-wheel trick when anyone stood before its cage. With great swiftness it would run along the branch up the side of its box and along the roof, which was composed of rough board, and so back to its starting point.

Measurements: Male and female, 135. 160. 30. 10 mm.

DIPODILLUS LUTEUS Dollman

GERBIL

Native name.—Mbadya (Chigogo).

I captured one of these gerbils at Dodoma one evening as it ran across the path in the moonlight; it was kept in a small cage which it shared amicably with a *Leggada bella bella.* Maize, potatoes, "mtama," and groundnuts were provided for it, and on these it subsisted for three months, and was still alive at the time of embarkation.

TATERONA SWAYTHLINGI Kershaw

SWAYTHLING'S GERBIL

Native name.—Mhanya (Chigogo).

Taken from a burrow into which it rushed from another that was being opened up in an attempt to capture a lizard. Kept in a zinc-lined box and fed on the same diet as the foregoing species; it thrived. These gerbils do not appear to be very common about Dodoma.

RATTUS RATTUS ALEXANDRINUS (Geoffroy)

ALEXANDRINE BLACK RAT

Native name.—Ngule (Chigogo); Panya (Kiswahili).

A great many Alexandrine rats were captured for feeding the owls, genets, and snakes.

RATTUS COUCHA MICRODON (Peters)

SHAMBA MOUSE

Native name.—Mhanyalusangha (Chigogo).

Not common at Dodoma apparently, though six were taken in a wire trap in one night, almost the only occasion on which any were trapped. They were killed and eaten by *Psammophis subtaeniatus* and *Bitis arietans.*

LEGGADA BELLA BELLA Thomas

PIGMY MOUSE

Native name.—Chimhanga (Chigogo).

During May and June half a dozen of these little creatures were captured on the premises, usually discovered when moving cages. The diet supplied to the gerbils sufficed for these also, though at the time of writing all have escaped save one.

ARVICANTHIS ABYSSINICUS NEUMANNI (Matschie)

UNSTRIPED GRASS RAT

Native name.—Fudi (Chigogo).

This abundant diurnal species was the rat most commonly trapped for feeding the owls. The great drawback to trapping them was the

thieving habits of the Wagogo, who appreciate wire traps to such an extent that they stole more than a dozen of them. It seems probable that our trappers were watched from afar as an attempt was made to conceal them. Petty thieving should be taken into consideration by anyone contemplating collecting or residing in the Dodoma district.

*PEDETES CAFER DENTATUS Miller

SPRINGHAAS

Native names.—Kesi (Chigogo); Kupa (Kiswahili); Sembe (Kikimba).

Occurs close to Dodoma station; one was brought in from Kifukulo, eight hours away; another was trapped at Mukwese; and yet another came from Kondoa Irangi. There is no reason why this animal should not do well in captivity under favorable conditions. The two we have now have been fed for the past couple of months on maize, "mahoga" (native potatoes), "mahikwi" (pumpkin), and groundnuts. They will take the maize cobs from one's hand and, holding them in their short, front paws, sit up at once to eat them. By day they sleep all huddled in a heap, their heads concealed. They wake up late at night and hop on their hind legs about the room, which they shared with a dozen porcupines. They should not be confined in a small cage, as they will jump against the roof until they wear all the fur, skin, and flesh from the top of their heads. The cage must be metal lined, as their powerful front teeth make short work of any wood; ordinary wire netting soon succumbs to these same teeth. After the foregoing was written, and three days before they would have been removed, one of these hares was killed by a porcupine as related below.

HYSTRIX GALEATA Thomas

PORCUPINE

Native names.—Nungu (Chigogo); Nungu (Kiswahili).

Porcupines were brought in from near Dodoma, Kondoa Irangi, and Shinyanga. At Mukwese, a bell-like note was heard nightly in the plantations after 10 o'clock; I mistook it at first for the cry of a hunting dog, but the local natives declared that porcupines were responsible.

They were fed on precisely the same food as the jumping hares, while young porcupines, much larger than a domestic cat, showed great fondness for milk. One little beast, who used his teeth offensively on the hand that put milk into his cage, seized the bowl in his teeth and would run backward with it, and usually upset it. To see a small porcupine in a rage is an amusing sight; to the accompaniment of an explosive noise he stamps his feet, shakes and erects his quills, and sets those in his tail rattling, making himself altogether unpleasant

to handle. If confined in a room they will gnaw the doors in a most astonishing and persistent manner, and it is a stout cage that will hold a porcupine in captivity for long.

Just a few days before embarkation, the porcupines killed a jumping hare, and ate more than half its head, this despite the fact that they had occupied the same room for two months.

HELIOPHOBIUS EMINI Noack

BLESMOL

Native name.—Fuko (Kiswahili).

A single blesmol was captured in the road near Dodoma and was placed in an empty paraffin drum three-quarters filled with earth. The drum was covered with double-wire netting (single soon gave way), which it spent its time in gnawing very persistently during the two months of its captivity. It throve and was in excellent condition and its death was entirely due to the negligence of a native attendant. Maize, European potatoes, and groundnuts were its food. Occasionally the earth was damped to make it bind better for the burrowing operations of the blesmol; and it was changed once a fortnight.

LEPUS species

HARE

Native names.—Sungula (Chigogo); Sungula (Kiswahili).

Hares are decidedly scarce in the neighborhood of Dodoma. I only encountered one in the open and that was near the station; at Saranda they are comparatively common. A young one as tame as a domestic cat was presented to the expedition by some ladies living near Dodoma. It drank milk from a saucer, nibbled grass, and if put down made no attempt to escape.

A very emaciated adult was brought in by a native who alleged he had run it down. It was found to be swarming with fleas (*Ctenocephalus felis* and *canis*, also *Echidnophaga* species), ticks (*Rhipicephalus appendiculatus*, males and females, *Haemaphysalis leachi*, males and females), and worms (*Dermatoxys velligera*), when it died (August 28, 1926), and a nymphal tick of the family Ixodidae a couple of days later. Measurements of adult female are 460. 10. 120. 125 mm.; young female, 235. 50. 70. 80. mm., taken on August 6, 1926.

THOS MESOMELAS MCMILLANI Heller

MCMILLAN'S BLACK BACKED JACKAL

Native names.—Nchewe (Chigogo); Bweha (Kiswahili)

Two jackals were box trapped at Dodoma, a locality where they are very abundant. One of these animals gave birth to five puppies on July 24, but she ate one and would not feed the others. Another, a male, which was preserved, measured 170. 75. 30. 10 mm.

Three puppies from near Dodoma were brought in on August 20, and were of the same size as four from Kondoa Irangi, received somewhat earlier the same month. The black pelage at birth gives place to an almost uniform fawn color, on which the black and silvery saddle marking subsequently makes its appearance. Four adults were also trapped at Kondoa Irangi and one of these, as the attendant was cleaning out the cage, made a successful dash for liberty the morning after its arrival. It easily led the chase across the common to the village and away beyond. On two occasions one of the Dodoma adults escaped. Each time I was apprised of this by the fluttering of the birds in their cages and on going out saw the jackal in the moonlight. The first time it ran into the kitchen and sought refuge under a table in the corner. Salimu pulled it out by its tail and carried it snapping wildly to a box in which it was shut until morning. By day a jackal has such a benign and mild expression that one could scarcely credit the difficulty of handling it at night. Their bite commands respect. Nikola was transferring a jackal from one cage to another, wearing thick leather gloves for the purpose; as he pulled the jackal out by its tail there were two quick snaps and Nikola found himself divested of both gloves and the thumb of the left glove snipped off as if by shears!

The first escape was achieved by biting through wire netting, the animal forcing its way through and losing much fur in the process; the second time it got out by gnawing a board along the bottom of its cage and squeezing through an aperture 4¼ inches in height.

Their food was chopped meat, varied from time to time with bush fowl; duck they would not take, preferring to starve; nor would they touch cooked mealie meal unless it was mixed with a heavy percentage of minced meat. About 4 or 5 o'clock in the morning, they generally quarrelled, as I was informed by the sharp yelps and scuffling, but on going to inspect with a lantern I would be met by mildly blinking eyes and most innocent expressions.

LYCAON PICTUS subspecies

HUNTING DOG

Native names.—Iminzi (Chigogo); Umbwa ya mwitu (Kiswahili).

A native "skin" from Msanga near Dodoma was brought to us by a native one day.

OTOCYON VIRGATUS Miller

EAST AFRICAN LONG-EARED FOX

Native name.—Nchenjeje (Chigogo).

Two foxes now in the collection were caught as adults at Kondoa Irangi. They appeared to subsist on next to nothing and never cleared up their plate except on one occasion when minced boiled

eggs and meat were given them. After a day or two they tired of this and were put back on raw minced meat. None of the things so relished by my Mkalama fox tempted them, sweetened cereals or papaw were left untouched. Milk, and bread and milk, they liked in moderation.

This animal seems fairly common at Saranda, for Mr. Robbie showed me an earth where, one morning, he had seen eight basking and killed five with three cartridges from a 12-bore shotgun. He was under the impression that they were jackals. One evening I met a fox which seemed remarkably bold and curious. Salimu shot it later and I was able to show Mr. Robbie its intestines (the stomach being empty), crammed with termites' heads, as evidence of its harmless diet and usefulness. It was a male and measured 520. 230. 40. 90 mm. and had two large cysts beneath the left foreleg and two smaller ones on the intestine.

MELLIVORA CAPENSIS Schreber

CAPE HONEY BADGER

Native names.—Muhiru (Chigogo); Nygeri (Kiswahili).

Early in August a two-thirds grown ratel was brought in uninjured; no suitable cage being available, it was put into an ordinary one with its face toward the wall and this cage was weighted above and behind. I visited it several times in the night. Next morning, as I had anticipated, the wire netting was torn to rags. It was transferred to a new cage but ate through a stout post, splintered others, and dropping 4 feet to the floor roamed about the room which held over a hundred boxes of birds and animals. At daybreak I located it behind some bird cages and shut it in by pushing the cages to right and left of it against the wall. A box trap was then set in the doorway and a barricade of cages built up to form an avenue from the spot where the ratel was to the door; of course, the backs of the cages were turned toward the avenue. By pulling out the cages that had been pushed back to inclose the ratel the avenue was now opened and a few pokes started the animal on the way that ended in the trap. The ratel makes a hoarse rattling sound in its throat, which, together with its snarl, would do credit to a leopard. It was fed on raw meat, dead birds, and mealie meal porridge mixed with black treacle.

CIVETTICTIS CIVETTA ORIENTALIS (Matschie)

EAST AFRICAN CIVET

Native names.—Fungo (Chigogo); Fungo (Kiswahili).

Taken at Dodoma, Kondoa Irangi, Shinyanga, and Tulo. The Kondoa Irangi specimen was fed on meat, groundnuts, and papaw; it would not touch pumpkin. Its cry, given just after dark and at

intervals throughout the night, was very harsh yet catlike. The Dodoma civet was a big animal, box trapped with a goat head and entrails as bait; it was very fierce and dashed against the bars or gnashed on them before it was brought in.

GENNETTA DONGALANA NEUMANNI Matschie

NEUMANN'S GENET

Native names.—Nghanu (Chigogo); Kanu (Kiswahili).

A dozen genets were brought in at Dodoma, Kondoa Irangi, and Tindi in Shinyanga. They were fed principally upon chopped meat, varied occasionally by small birds or rats. In the morning they were provided with milk (of which they were very fond), and in the evening with water. I found it advisable not to keep more than two in a cage on account of their fierce disposition and the difficulty of cleaning the cage. A box containing two adults and a kitten was sent in from Kondoa Irangi; on arrival it was found that the adults had presumably killed and most certainly eaten the whole of the kitten except the tail and the rump around the scent glands. Another time when two adults occupied the same cage with a kitten they murdered it, though they did not eat it. A member of our party—S. Haweis—received a very severe bite from an adult genet, which held on for more than a minute; in fact its jaws had to be pried open before it would relax its grip.

HERPESTES (CALOGALE) FLAVIVENTRIS (Matschie)

OCHRACEOUS MUNGOOSE

Native name.—Muloli (Chigogo).

When first brought into our camp at Dodoma this handsome yellow little mungoose was very savage. While food was being placed in its cage or bedding removed it showed great activity, darting about the cage in every direction. Later it learned to come to the netting to take food from one's fingers, but I should hesitate to trust it with my fingers inside the cage.

HERPESTES (CALOGALE) GRACILIS LADEMANNI (Matschie)

BLACK MUNGOOSE

Three were brought in at Dodoma, and two of these, after spending two months in captivity, escaped; one was recaught a week later, having entered an outbuilding; he left again a few days afterwards. All were fed on minced raw meat, eggs, and milk, and remained fit and fierce.

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ATILAX PALUDINOSUS RUBESCENS (Hollister)

WATER MUNGOOSE

Originally caught by Mr. Runton and his boys at Mbulu, this mungoose arrived with a great reputation for ferocity, which his attitude justified. After about three and a half months' captivity, having discovered that the function of mankind was to feed him, he became tolerant and learned to drink out of a saucer without interfering with the fingers at the other end. His appetite was enormous; occasionally he overstepped even its limits and was then disgustingly sick. This happened three times in three months and a day's starvation with plenty of water was all that he required to enable him to recover the health of which his sleek and glossy coat bore witness. He would reach into a wire rat trap, scoop out the occupant, and crush its skull in a matter of seconds. An animal which I believe was a water mungoose was sighted by Mr. Haweis and myself near the swamp at Nzingi.

ICHNEUMIA ALBICAUDA IBEANA (Thomas)

EAST AFRICAN WHITE-TAILED MUNGOOSE

Native names.—Nghungangombe (Chigogo); Chonjwe (Kiswahili).

A half-grown specimen brought in during May would only eat raw meat and drink milk; of the latter he was exceedingly fond, drinking nearly half a pint daily, but milk puddings or rice he ignored.

When a hand was put into his cage he gave vent to a long drawn-out screech which terminated with a dab or snap at the offending hand. Protected by a glove, I daily rubbed his ears or stroked his head; nevertheless he would maintain his outrageous screech the whole time.

An adult female, also taken near Dodoma, measured 500. 500. 120. 30 mm.

HELOGALE UNDULATA UNDULATA (Peters)

LESSER MUNGOOSE

Native name.—Sala (Chigogo).

Only two specimens came to hand, one at Dodoma and the other at Kondoa Irangi. They were fed on milk, minced meat, and occasionally eggs, a diet which appeared to suit them perfectly. They were quiet little animals, retiring to a corner of their cage and chirruping when food was being put in or during cleaning operations.

MUNGOS MUNGO COLONUS (Heller)

BANDED MUNGOOSE

Native names.—Nghalasanga (Chigogo); Ngutchiro (Kiswahili).

Seen at Nzingi; very abundant at Mukwese and Saranda.

Four banded mungoose were brought in at Dodoma and a fifth from Shinyanga. One of these escaped permanently. All of them got loose a great many times, mainly owing to the carelessness of native attendants in leaving the door catch unfastened. The mungoose apparently tested the door every time it was opened, for they never seemed to lose an opportunity of which they could take advantage. They lifted the door by pressing their noses against it. I am not sure that one alone could escape, for generally a second animal was required to slip its claws underneath and raise it further. One large mungoose bit through the wire netting several times, but doubling the net dissuaded them from further experiments in that direction. With the solitary exception already mentioned, they never went far, almost invariably retiring behind their own stack of cages and remaining there until disturbed. Then generally ensued a wild chase around the room. Their dietary was minced meat, eggs, milk, and water; the latter they habitually upset by pawing at the pan, so that it became necessary to hold it while they drank.

Fleas (*Ctenocephalus felis*) were removed from one.

Measurements of male, 385. 240. 80. 20 mm.

CROCUTA CROCUTA GERMINANS (Matschie)

EASTERN SPOTTED HYENA

Native names.—Mbisi or Mvisi (Chigogo); Fisi (Kiswahili).

Four hyenas were trapped at Dodoma and one at Kondoa Irangi. The bait was tied to a peg which released another peg that took the weight of the door so that the latter dropped instantaneously when the bait was grabbed. Our first hyena howled at nights and this drew many callers about the house. On moonlight nights they might be seen standing or sitting and calling to one another in sympathy. An old one accompanied by a puppy were very regular in their appearance and would sit 50 feet from the cage in which their confederate was confined. The captive whimpered and yelped like a dog and scrambled at the bars in his excitement. These demonstrations ceased after two more hyenas were introduced into the cage, when by day all would lie in a lazy pile at the back of the den for all the world like so many dogs. When first confined the larger ones resented the raking out of their bedding by seizing the rake in their powerful jaws or making rushes at the bars to the accompaniment of deep-throated growls or rumblings. Seemingly realizing the futility of this conduct they would retire to the back of their cage and turn their heads down and under in a characteristically hyenalike position of abject fear. Three lived in greater harmony than two, for when there were two the big Kondoa beast bit or bullied the young Dodoma animal toward dawn—that is, after 4 o'clock and before 6.30 o'clock—then the young ones would yelp and I

would hasten out in my pajamas and wallop the bully, or hang a lantern in front of the cage. A light always had a quieting effect. The young hyena was not so shy and would come to the bars and lap up water within a foot of me. Woe betide the water dish (whether heavy aluminum or stout enamel ware) which was left in their cage overnight; morning had nothing but some shreds of metal to show for it.

Apart from this vice I considered the hyena party my best friends and, with the exception of their dawn disputes, the least troublesome animals to look after. Any bones, skins, or entrails left in the leopard cages were always transferred to theirs. Any diseased animal that died was soon buried if handed over to them.

They had enormous appetites, but they lived well, nevertheless.

FELIS LEO MASSAICA Neumann

EAST AFRICAN LION

Native names.—Simba (Chigogo); Simba (Kiswahili).

Lions were never heard for certain during our four months' stay at Dodoma, though visiting lions were not uncommon at Kikuyu (1½ miles south), where they killed cattle from time to time. Six miles east they were a good deal in evidence by the Greater Kudu kills, and the only time I was out in that direction I came upon the stomach contents of an ox quite close to a large village whose inhabitants said a lion had killed there at noon the previous day.

FELIS PARDUS SUAHELICA Neumann

EAST AFRICAN LEOPARD

Native names.—Suwi (Chigogo); Chui (Kiswahili).

Four leopards were trapped at Dodoma and one at Kondoa Irangi; three of these Dodoma leopards were taken in six days or the second week after the traps had been set. The cage trap was placed against a "boma" (thorn zareba) containing a live goat plainly visible to a prowling leopard who, if he entered the cage and approached the bars, would tread on a plank connected with a peg as in the hyena trap previously mentioned. During the last fortnight one leopard and three hyenas were taken in four traps set on the same spot. The ferocity and wrath displayed by freshly caught adult leopards are quite appalling, and to prevent such animals injuring themselves on the bars it was found necessary to cover these with sacking for the first couple of weeks, as anyone looking in or passing by caused a fresh outburst of rage.

Their food was always killed before being put in, and consisted chiefly of bullock and goat flesh, varied by guinea fowl. It was interesting to observe how neatly a guinea fowl was plucked before

being eaten. Holding the bird in its claws the leopard would remove mouthful after mouthful of feathers which would be laid in a neat pile similar to others composed of bustard's feathers which I saw in the bush at Saranda. Similarly if given a whole dikdik the stomach and entrails would be removed and laid on one side. Curiously enough, while bush fowl were relished, duck would not be touched by any of the leopards, which were presumably unacquainted with them. One fine male, taken at Kikuyu, refused both monkey and baboon, but this was certainly a personal idiosyncrasy not shared by his companions in captivity. A dead python cut in half was also rejected by the two leopards to which the pieces were offered.

While staying at Nzingi station one of our boys reported seeing two leopards at daybreak as they trotted down the line. Local natives said it was a daily occurrence, as they came to drink at a water hole close to the station. At Kilamatinde I saw one in the road one morning, and at 3 o'clock on Sunday afternoon a pack of baboons on the hillside opposite the "boma" gave tongue and acted as if they had been molested by one. In the same way, but at 9 o'clock in the evening, guenons raised an outcry in the trees at the back of the house at Saranda where leopards were quite a pest. The second night I was there, one carried off a calf out of a shed, the little creature had only been born that afternoon. Mr. Robbie pointed out the skeleton of another calf hanging in the fork of a tree at a height of 20 feet from the ground and perhaps 50 yards from the cow shed. In that instance Mr. Robbie set a gun trap at the foot of the tree, thereafter the leopard's skin adorned Mr. Robbie's house and the calf's carcass was left in the tree.

FELIS CAPENSIS HINDEI Wroughton

EAST AFRICAN SERVAL

Native names.—Nzuli (Chigogo); Kizonga (Kiswahili).

Seven servals in all were received by the expedition. Two of these were adults, gin trapped by natives close to Dodoma. Three were kittens, of which one came from Kizumbi, near Shinyanga; another from Arusha was presented by Mr. Montague of the game department, and the third was bought at Kondoa Irangi. All were about the same size and were received during July and August, but while the Kizumbi and Kondoa animals might be freely handled and were allowed to run loose about the camp, the Arusha serval was irascibility personified, spitting and slapping with extended claws at anyone approaching.

It was an amusing sight to see these kittens wrestling with their milk bottles—ordinary liquor bottles fitted with a teat. Standing on their hind legs, each with its forepaws around the bottle's neck, they would growl and struggle with the teat most ferociously. On

the arrival of our train at Dar es Salaam Mr. Charlton wished to obtain a photograph of one of them. Abedi, in whose charge it was, removed it from its cage; while not far away was a crowd of about 50 natives who could be heard discussing it as a "young leopard," etc. Suddenly the tiny kitten broke loose and cantered toward the crowd, which gave back; a youth, however, who was about 17 years of age, completely lost his nerve and took to his heels down the line, with the diminutive feline in full pursuit. After doing 30 yards to his 60 she became tired and sat down to rest. The incident evoked peals of laughter from the remaining onlookers.

FELIS OCREATA UGANDAE Swann

UGANDA WILD TABBY

Native names.—Mvugi (Chigogo); Paka wa pori (Kiswahili).

Two wildcat kittens were brought in during May, both taken near Dodoma. An adult was sent in from Kondoa Irangi and F. G. Carnochan obtained a dozen kittens from the Shinyanga subdistrict. Two of these were half-castes, one of their parents being a domestic cat, the young having patches of white upon them. All displayed great ferocity, spitting and striking incessantly when food was put into their cage or on any other occasion when their cages were approached; apparently it was second nature to them to do so and so they they did it, however irrational. No deaths occurred among them; all were given milk and chopped raw meat, the latter occasionally varied by mice or small birds when these were available.

LYNX CARACAL NUBICUS (Fischer)

EAST AFRICAN LYNX

Native names.—Mangu (Chigogo); Simba wagi (Kiswahili).

F. G. Carnochan purchased a kitten from natives at Kizumbi which was still alive at time of embarkation, its diet being minced raw meat and milk. The Shinyanga region appears to be one of the few places in Tanganyika Territory where the lynx is tolerably common, judging from Mr. Carnochan's experience. Salimu tells me that "wagi" refers to its color, which they compare to the buffalo bean ("wagi" in Kikami, a word adopted by the Swahili).

SMUTSIA TEMMINCKI (Smuts)

PANGOLIN

Native names.—Nyamungumi (Chigogo); Kakakuona (Kiswahili).

One of these curious armor-plated creatures was brought into Dodoma early in June and was still alive at time of embarkation, though it should surely have died before then. At first it was fed on minced raw meat and boiled rice, but it ate so little of the latter that the rice was dropped. It occurred to me that boiled eggs and

boiled meat minced together might adhere to its sticky tongue better than raw meat. The change was greatly appreciated and the pangolin ate tremendously for a time, then dropped back to about a cupful each night, a quantity which seems extraordinarily little for an animal of its size. It frequently protruded its long wormlike tongue through the wire screening of its cage and it drank water by putting its tongue into it continually. It spent much time in clawing at its cage in an endeavor to escape. The species also occurs at Manyoni.

BUBALIS COKEI subspecies

COKE'S HARTEBEEST

Native names.—Bwindu (Chigogo); Kongoni (Kiswahili).

As the Wagogo always assert that hartebeest do not occur in Ugogo I was surprised to see a solitary specimen some 3 miles north of Mukwese (near Manyoni). I obtained a clear view at 200 yards distance.

CONNOCHAETES TAURINUS HECKI Neumann

WHITE-BEARDED GNU

Native names.—Nghongolo (for wildebeest in Chigogo); Nyumbu (Kiswahili).

The four young animals which Doctor Mann's party captured at Mbulu, Arusha, were transported in safety by Chrysler car to Dodoma at the end of May. A month later one of them succumbed to eruptions from which it was suffering at the time of its capture; the others all survived. They were fed on grass, usually rather too dry, and this was varied by potato tops during the last month. All attempts to get them to take mealie meal either with or without milk failed for some time. Doctor Mann soon discovered their liking for Quaker Oats and so they were given two tins of this daily for a long time. Later we tried mixing maize meal with it; at first they refused the combination, then sought to select the oats, but eventually took to eating the mixture, which by very gradual degrees, extending over a month, was so altered that finally the oats were entirely eliminated and the animals took the mealie flour neat. At first they drank two whole washbasins of milk daily, but as they grew older they took more water and less milk. The ailing animal liked having its head rubbed and would approach me to be fondled, but the other three resented all overtures, characteristically kicking up their heels and bounding away.

Ticks (*Rhipicephalus appendiculatus*) were found on the ears of one of these wildebeest.

Measurements of a young male were 45½ inches, 10½ inches, 15 inches, 7 inches.

*CEPHALOPHUS GRIMMI GRIMMI (Linnaeus)

COMMON DUIKER

Native names.—Haluzi (Chigogo); Funo (Kishwahili).

I saw half a dozen duiker at Nzingi, Saranda, and in the vicinity of Dodoma. Several young ones were brought into camp at Dodoma during May and June and others from Kondoa Irangi and Shinyanga in August, showing a very extended breeding season, as all were about the same age. An adult female which arrived from Kondoa Irangi during the first week in August was with young.

I had one of the Dodoma duikers combed for fleas (*Ctenocephalus felis*) during June.

Measurements of male, 1054. 61. 264. 108 mm. (Mukwese).

MADOQUA KIRKI NYIKAE (Heller)

THORNBUSH DIKDIK

Native names.—Mzimba or Chizimba(Chigogo); Paa (Kishwahili).

The pronunciation of the Chigogo name for this species varies in different sections of the district. Dikdik are extraordinarily common, even quite close to Dodoma, and on my first three walks in the vicinity I put up three dikdik on each occasion. I saw several at Nzingi and Mukwese, where it is not so abundant. At Saranda it is very plentiful. At least a score of newly dropped young were brought in during May, June, and July. None of these lived more than a fortnight, either through the curdling of the cow's milk in their stomachs or through diarrhea. The last received during the first week in August was kept in a cool ill-lighted room and fed on cow's milk diluted with equal parts of water three times a day. It throve, began nibbling grass, and in due course was taken to Dar es Salaam. This little animal always slept with a serval kitten, which, in the daytime, would spring on its back or cling round its neck in an attempt to throw it, making a fine miniature scene of a leopard with an antelope. The dikdik stood this treatment quite placidly and showed no fear whatever, even going up to rub noses with the serval. The Zanzibar lemur would sometimes join the party and seize the serval's big ears or prance around on its own long hind legs in a grotesquely ludicrous fashion. In captivity the dikdiks ate maize flour, mimosa pods, mimosa leaves, and showed considerable fondness for the green tops of potatoes and beans. Most of the native garden plots at Mukwese are guarded by felled hedges, at intervals along these are set well-made deadfall traps presumably for dikdik; at least I can hardly imagine anything much larger venturing through the narrow aperture.

Fleas (*Ctenocephalus canis* and *felis*), ticks (*Rhipicephalus appendiculatus*), and worms (*Setaria labiado-papillosa*) were collected from Dodoma dikdiks on June 11 and 26, 1926.

* RAPHICEROS CAMPESTRIS STIGMATICUS (Lönnberg)

STEINBUCK

Native names.—Not known (Chigogo); Dondoro (Kiswahili).

I could never get the correct Chigogo name for this species, always being given that of the duiker or oribi instead. Two young ones were brought into Dodoma in June and a third from Mbulu in May. The latter died from pleurisy, the former from undiagnosed causes, but all had numberless fleas upon them, though they lived in an open paddock.

Fleas (*Ctenocephalus felis*) were collected on one of these bucks at Dodoma on June 27, 1926.

REDUNCA REDUNCA TOHI Heller

REEDBUCK

Native names.—Mpunzu (Chigogo); Tohi (Kiswahili).

Reedbuck were also kept with some degree of success. On May 20 I saw a pair owned by the station master at Bahi. The brown male was very young and he had only had it for about a week. The reddish female was nearly twice its size and was grazing at large, though still being given nine medicine bottles of milk daily; these it sucked through a piece of football rubber wound around the neck of the bottle. So eager was it for its milk that the sight of the bottle at feeding time would send it racing to its owner and vigorously attacking the back of his knees.

At Bahi I bought two young males, but both had diarrhea and one died the same night. The other was fed on water and milk for one day, then given bismuth with milk on the second; this resulted in a complete recovery. A fortnight later I again left Dodoma for 10 days and on my return found the animal looking miserable with a second attack of diarrhea. Once more it reacted to the bismuth treatment and became a great pet. In the middle of August it was in high spirits, racing and jumping around its inclosure and chasing the crowned cranes for sheer mischief. I removed it to the antelope paddock, where, about the 25th of the month, it very suddenly sickened, with a heavy discharge of mucus running from its nostrils. It stood up continually, as if it found some relief in this position. There was no apparent temperature or other sign of a cold, and though everything possible was done for it, it succumbed on the third night after being taken ill.

In half an hour spent in the Bahi swamp I saw or heard nearly a dozen reedbuck, sometimes singly, sometimes in pairs. I walked to within 30 feet of one doe, which was either busy feeding or purposely kept her head down, though I could see her back from afar. When approached she plunged away for 50 yards through the knee-deep water, then stood calmly regarding us.

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Another male reedbuck was obtained by Doctor Mann at Arusha; its pelt was more rufous than was that of the Bahi animal. It took milk in considerable quantities during the whole period of its captivity until it was shipped three months later. The milk was given it through a leather funnel shaped like a shoehorn, nor could the obstinate animal be induced to drink it in any more reasonable fashion, though its companion drank from a bowl. Like the Bahi reedbuck it became riotously persistent at feeding times and many a bowl of milk was knocked out of the attendant's hands. Reedbuck make delightful pets and are probably easy to rear when given individual attention.

Fleas (*Ctenocephalus canis*) were collected from a young animal taken at Bahi, May 21, 1926, and others (*Ctenocephalus felis*) on the same animal at Dodoma some few weeks later.

AEPYCEROS MELAMPUS SUARA (Matschie)

IMPALLA

Native names.—Mbata (Chigogo); Palla (Kiswahili).

Impalla occur 6 miles east of Dodoma township, where I have seen their spoor; the natives were aware of their presence. I saw one at Nzingi, which is due west of Dodoma, and half a dozen were seen not far from Saranda station.

A young one was brought in during July, but died within a few days. Later a pair were obtained at Kondoa Trangi by Mr. Runton and four females at Tulo by Doctor Mann.

Measurements of immature female, 700. 170. 305. 110 mm.

GAZELLA THOMSONI Günther

THOMSON'S GAZELLE

Native names.—?Mpunzu ?Nzera (Chigogo); Lala (Kiswahili).

I saw a single individual grazing on an open plain near Bahi in the Dodoma district May 20, 1926.

TRAGELAPHUS SCRIPTUS MASSAICUS Neumann

MASSAI BUSH BUCK

Native names.—Mbala (Chigogo); Mbarawara (Kiswahili).

I anticipated that we should get bush buck more certainly than any other species of antelope, but owing to the fact that the main activities of the expedition were not in bush-buck country it so happened that none was received until the collection was on its way to the coast, when Mr. N. C. Miller, of the game department, presented us with a very young animal found at Kilosa a few days previously.

STREPSICEROS STREPSICEROS BEA Heller

EAST AFRICAN GREATER KUDU

Native names.—Sichilo (Chigogo); Tandalla (Kiswahili).

Mr. George Runton captured two well-grown but still hornless male kudu at Kondoa Irangi. While one of these animals was on the way from Kondoa to Dodoma it was scared by a passing car and sprang out through the wooden end of its cage carrying all before it. Its cage was in the box body of the car at the time and the kudu made good its escape. The other fed on shrubs and potato tops, but as far as I could see did not touch grass.

This fine antelope is still fairly common quite close to Dodoma, herds being seen by me on several occasions. While their spoor was plentiful at Mukwese, only one animal was seen.

TAUROTRAGUS ORYX PATTERSONIANUS Lydekker

EAST AFRICAN ELAND

Native names.—Mhogologo (Chigogo); Pofu (Kiswahili).

A fine young animal was obtained at Kizimbi by F. G. Carnochan. It took six bottles of milk every day—two in the morning, two at noon, and two at night. It began to eat early in August. A herd of eland in charge of a magnificent bull were seen one afternoon at Mukwese.

GIRAFFA CAMELOPARDALIS TIPPELSKIRCHI Matschie

GIRAFFE

Native names.—Nhwigga (Chigogo); Twigga (Kiswahili).

Measurements of adult female, 13 feet 3 inches, 2 feet 10½ inches, 4 feet 8¾ inches. Saranda. When proceeding up country on May 10, 1926, many young giraffe were seen on Mkata plains. At Mukwese a solitary female and calf were met with in thorn bush and half a dozen adults with two yearling calves were encountered in an "mbugwe." It was at Saranda, however, that I saw the finest lot of calves I have ever seen. Mr. Robbie took me out to the acacia flats on the evening of my arrival and pointed out a herd some 400 yards away. We approached to within 200 yards and were watching them with glasses across a perfectly open "mbugwe" when a wart hog, totally unconscious of our presence, trotted past within 50 yards. The giraffe were a wonderful sight—15 or 20 of them and only 1 large bull. Several unaccompanied females strolled past, feeding as they went. They were followed by some of last year's young, then several more females accompanied by young ones only 6 feet high. The bull came last but two; the laggards were a yearling and a this year's calf. The variety of coloring was very striking, one young one being nearly white; on others the markings were reddish, while on

several they were rich sepia brown. There seemed to be a tendency to darken with age. Robbie estimated the age of the younger calves at 3 months (Saranda, September 13, 1926).

Ticks are always abundant on these big beasts and some (*Amblyomma gemma*, *Rhipicephalus* species, *Hyalomma aegypticum*, and *Ornithodorus moubata*) were collected at Mukwese near Manyoni.

EQUUS QUAGGA subspecies

ZEBRA

Native names.—Nhyenje (Chigogo); Punda milia (Kiswahili).

A zebra, purchased from Masai herdsman at Mbulu, was brought into Dodoma after a month's rest at Kondoa Irangi.

It was a tremendous feeder, consuming much green grass and regularly ate down the dry grass which formed one side of its hut. On the fifth day I had the hut constructed of inedible leaves and branches; these, though a poorer shelter than grass, afforded sufficient cover. Though three-quarters grown it was still very fond of milk, and would make short work of a washbasinful; it also took maize meal in a basin of water.

PROCAVIA BRUCEI PRITTWITZII Bauer

HYRAX OR CAVY

Native names.—Mhimbi (Chigogo); Pimbi (Kiswahili).

These hyraces, formerly so common on the kopjes around Dodoma, are much more difficult to obtain now, as they have evidently been killed off for food quite extensively. Only about 10 were purchased locally, but many others were obtained at Bahi and Kondoa Irangi.

At first great difficulty was experienced in finding proper food; acacia thorn they would eat, but not heartily. Salimu then suggested the leaves of a locally grown bean and those of potatoes. Thereafter no further trouble was experienced, excepting the difficulty of procuring these leaves in sufficient quantities to appease the hearty appetities of 30 hyraces.

Many species of worms (*Crossophoris collaris*, *Setaria* species, *Physaloptera* species) were taken from a Dodoma hyrax.

AVES

Familiar as I have been with large numbers of waterfowl on East African lakes like those at Singida, I have never seen anything quite so staggering as the flocks which were encountered near Bahi in May. South of the line are some extensive swamps covering miles of country; as the water recedes mud banks and spits of sand are exposed and on one such alone I approached within a hundred yards of a flock of pelican numbering between two and three thousand. When I came

too near they would run a yard or so to get impetus and then the whole flock would take off and fly a couple of hundred yards before settling again.

Palm trees in the distance were white with wood ibis, another species of which there were also many thousands; smaller flocks of sacred and glossy ibis, openbill, and spoonbill were also put up. During eight years in East Africa I have only seen half a dozen giant heron, but here in the course of an hour I saw a dozen, several of them rising with catfish (?) in their beaks. Gray heron, black-headed heron, squacco heron, great white, and other species of egret were abundant, while one saw not a few saddle-billed storks with wing spread of 8 feet—a bird one is accustomed to consider a rarity. Gulls and grebes were also present, but like the geese and ducks were not as plentiful as the pelicans and ibises. I recognized spurwing and Egyptain geese, knob-bill, redbill, and fulvous whistling duck. Fish eagles and other large birds of prey were represented.

For four and a half hours I sought for nesting sites but though old nests were found, those of this year I could not locate. The explanation given by the natives was that the provincial commissioner had given orders for all nests to be destroyed, as the presence of the birds was considered to interfere with the local industry in dried catfish. In consequence of this treatment the birds were now nesting farther back in the wilderness of swamps in places unknown to the Bahi natives.

CHLIDONIAS LECOPAREIA sclateri Mathews and Iredale

TERN

A male was shot and preserved in spirit. Several which were seen flying over the swampy "fields" or flooded areas looked very out of place among the green grass. To judge by their behavior one pair almost certainly had their nest among the grass tussocks standing out of the water. (Nzingi, 25. v. 26.)

STRUTHIO CAMELUS MASSAICUS Neumann

EAST AFRICAN OSTRICH

A native brought in a well-grown but immature ostrich, a species of which I saw a large drove near the Bahi swamps just mentioned.

This bird was taken out to graze and feed every day and returned to its inclosure during luncheon hours. One day some one inadvertently left two crowned cranes in this "boma" and on my going out to see how the ostrich fared I found it standing with one foot on a crane which it was eating alive. As I paused in astonishment it tore off another piece of flesh and gulped it down, its bill dripping blood. The sight brought to mind pictures of dinosaurs of old feeding on their victims. (Dodoma, v. 26.)

ANAS ERYTHRORHYNCHA Gmelin

REDBILL OR AFRICAN PINTAIL

Three young birds, just able to fly, I think, have just been brought in from Malenga. One met death at the beak of a sacred ibis, the others fed well on chopped meat and rice submerged in water in a soup plate. (Dodoma, 1. vii. 26.)

THALASSORNIS LEUCONOTUS LEUCONOTUS Eyton

WHITE-BACKED DIVING DUCK

Twenty-three young birds were brought in from Nzingi during the middle of August; the diet of minced meat and boiled rice in water did not suit them.

DENDROCYGNA FULVA (Gmelin)

FULVOUS TREE DUCK

Common on the swamps at Nzingi and Bahi in May, black duck (*?Anas sparsa* Eyton) and many other species were also seen, almost invariably in pairs. (20–26. v. 26.) As they were unaccompanied by young, I concluded that they were not nesting as yet, certainly not sitting, for the females accompanied the drakes. Two nests which I found looked like old duck nests, however.

ALOPOCHEN AEGYPTIACUS (Linnaeus)

EGYPTIAN GOOSE

Seen at Bahi in May.

During the last days of June an adult and two young birds were brought in, the woolly necks of the latter looking very scraggy. Both the young birds died, presumably through competition of the older birds in the run. (Dodoma, vi. 26.)

SARKIDIORNIS MELANOTUS (Pennant)

KNOB-BILLED GOOSE

Very abundant and extraordinarily tame at Nzingi in May (24–26) where a flock of 20 permitted one to approach within 30 to 50 feet.

A single bird in an exhausted condition on being brought in was put in an inclosure to see if it would recover, which it did, flying away between dusk and dawn. (Dodoma, vii. 26.)

PLECTROPTERUS GAMBENSIS GAMBENSIS Linnaeus

SPUR-WINGED GOOSE

Six birds were obtained from the missions at Bahi and Kilamatinde, whither they had been taken by natives. The big birds have ravenous appetites, consuming large quantities of meat and rice, which are

furnished in a washbasin, the food being submerged in water. They also exhibit a liking for "mtama," heads of which are scattered on the ground in their inclosure.

This goose is such an arrant bully that it is not advisable to keep it in the same pen with smaller species; even young of its own kind lead a very precarious existence, for not only do the semiadult geese peck at any bird approaching when they are feeding but they will drive such away from the food even when they themselves have no inclination to eat. As if this were not enough, they are addicted to giving a peck in passing to the Egyptian geese and sacred ibis which perforce share the run.

Four almost adult birds were brought in during August, mostly from Nzingi, where I saw an adult on May 25. (Dodoma, vii. 26.)

BALEARICA REGULORUM GIBBERICEPS Reichenow

EAST AFRICAN CROWNED CRANE

About two a day were seen feeding in the native "shambas" at Nzingi in May. From the day of our arrival here on May 5 to the last day in July, young crowned cranes lacking the black velvet cap have been brought in at intervals of about 10 days with great regularity. Ten in all were received, the last, which arrived on July 31, having some black velvet feathers on the crown. Those received early in May were obviously only recently out of the nest, as they were scarcely able to fly. One met death at the beak of an ostrich, as previously related, while two, though able to stand and walk about when they were brought in, collapsed during the night and never recovered the power in their legs; they fed from a dish placed in front of them, but both succumbed after four or five days. The remaining seven did well in a small inclosure where they were fed exclusively on boiled rice and raw chopped meat submerged in water in an ordinary washbasin. They drank frequently from a big bowl of water which was always kept in their paddock, and often stood in the water when not engaged in picking about their quarters, which they do much after the manner of fowls. Most of the birds came from Nzingi and Bahi. (Dodoma, 5. vii. 26.)

A very young bird was brought in, being much less advanced than the Dodoma birds, hatched quite two months later, one would suppose. (Kondoa Irangi, 13. vii. 26.)

THRESKIORNIS AETHIOPICUS AETHIOPICUS (Latham)

SACRED IBIS

Sacred ibis were abundant at Bahi and Nzingi, but as I could detect no woolly necked young birds among them I concluded that they had not nested as yet.

Two of these birds were brought in early in May and contrary to expectations survived on a diet of boiled rice and chopped meat. One was little more than a fledgling, having been taken at Kiva Mtango on May 15, 1926, and still had all its neck feathers. (Dodoma, 31. viii. 26.)

*ARDEA MELANOCEPHALA Vigors and Child

BLACK-HEADED HERON

Strange to say, this was the only heron of any kind brought in during the whole trip. (Dodoma, 10. viii. 26.)

ANASTOMUS LAMELLIGERUS LAMELLIGERUS Temminck

AFRICAN OPENBILL

A fledgling was brought in from Mtangalala near Dodoma May 13, 1926, but it only survived a few days, though offered chopped meat in water. Common at Nzingi and Bahi.

*CHARADRIUS VENUSTA VENUSTA Fischer and Reichenow

PLOVER

A plover, kept in a cage with black rails, did well on boiled rice and minced meat. (Dodoma, vii. 26.)

STEPHANIBYX CORONATUS (Boddaert)

CROWNED LAPWING

The crowned plover is very common at Dodoma in May and June but appears to leave the vicinity as desiccation proceeds. Their cries at night were a considerable item of the nocturnal disturbances in May. Three birds survived in the bush-fowl run, apparently subsisting entirely on minced meat. The first birds brought in all died, either as a result of being snared by the leg or being confined in a box cage. (Dodoma, vi. 26.)

LIMNOCORAX FLAVIROSTRA (Swainson)

BLACK RAIL

About half the number caught survived when supplied with raw chopped meat and boiled rice, but whether they actually ate the rice I can not say. (Mbulu, vii. 26.)

SAROTHRURA ? species

RAIL

Three rails were brought in, one of which succumbed within a day or two; the others remained fit and well on a diet of rice and papaw, which they were never seen to take, as they apparently fed at night. They were active and stood captivity well, their plumage always immaculate. (Dodoma, vi. 26.)

GALLINULA CHLOROPUS BRACHYPTERA (Brehm)

AFRICAN MOOR HEN

Found 20 nests of the year all vacated by young except two. In one of these was a single addled egg, which I preserved. In the other were five hard-set eggs, which I left. All the nests except this last one were built in tussocks of grass; the last was in the fork of a shrub about 6 inches above the water, which was 4 feet deep; there was no grass within 10 feet of the site. (Nzingi, 26. v. 26.)

During the second week in May I saw a downy young moor hen swimming in the large pond near the golf links. A slightly larger youngster was brought in between May 12 and 15, but was too injured to keep. Toward the end of the month this was followed by an adult bird which was put in a spacious guinea-fowl run where it huddled in the corner all day, never venturing to enter a basin of water that was provided. It evidently fed at night when the guinea fowl roosted, for it survived and was joined by a half-grown, gray-plumaged bird and the two of them transferred to an inclosure occupied by small buck. Here the pair of them fed on rice (? and meat) submerged in milk. When anyone approached they raced up and down inside the wire netting scrambling over the buck with their sharp claws so that I deemed it advisable to remove them to an inside room pending the building of a water-fowl run. In this location they were equally at home, rarely entering the water but scurrying over the grass-strewn floor. The adult bird, finding it could pass through the bars of a large cage containing a pangolin and a jumping hare, took up its abode in the dark recesses of the cage, only issuing forth to feed at night. (Dodoma, vi. 26.)

Of four adult birds brought in only two survived; possibly they had been injured during capture or exposed to a hot sun. The Wagogo display a total lack of common sense in such matters. (Dodoma, 1. viii. 26.)

NUMIDA MITRATA REICHENOWI Grant

REICHENOW'S HELMETED GUINEA FOWL

Purchased two hatchings from native youngsters who had reared them under hens; there were five in one lot and four in the other. They are very fond of grasshoppers but reject a hard-shelled dung beetle (*Macropoda tuberculifera* Kolbe)[3] that is locally common. During the three days here—and I have been constantly in the bush—I have only seen two coveys of the birds, both were large ones, however. (Nzingi, 24–26. v. 26.)

[3] My thanks are due to Mr. Archer for this determination.

These guinea fowl, though now scarce in the immediate vicinity of the town, are very abundant elsewhere and the Wagogo are well versed in snaring them by the leg. Many of these birds are brought to the market, where they are sold at sixpence each, but either through having been left in the snare too long or subsequent rough treatment an appreciable percentage of the birds are lame. When a fresh arrival is introduced into a run containing guinea fowl the old inhabitants almost invariably attack, pecking it so viciously on the head as to frequently kill it outright. It is very necessary, therefore, to watch over a new bird until the attention of the others has been distracted by feeding or some other diversion. "Mtama" and "uwele," with a moderate amount of chopped or minced meat, was given them, but unless very hungry they did not appear to care for rice. Green potato tops are greatly appreciated, the leaves being soon stripped from the stems. (Dodoma, vi. 26.)

Scarce at Mukwese, though several large flocks from 20 to 30 individuals were encountered several miles out from the hamlet. (Mukwese, 4. vi. 26.)

GUTTERA GRANTI Elliot

GRANT'S CRESTED GUINEA FOWL

These birds occur along the well-wooded slopes of the Rift Valley escarpment, quite close to the station, while the helmeted guinea fowl occupies the "shambas" and thorn bush of the plains; the crested birds do visit the "shambas" at times, however, and four were snared by the natives. In captivity they show a greater preference for minced meat than the helmeted species; "mtama" formed their staple food. The cry is most peculiar, not unlike the noise of a watchman's rattle.

"Ugogo" is the type locality for this species, which Sclater considers a doubtful form of *G. plumifera* (Cassin). (Saranda, 15. vii. 26.)

PTERNISTES LEUCOSEPUS ?INFUSCATUS Cabanis (*or ?* BOHMI Reichenow)

EAST AFRICAN BARE-THROATED FRANCOLIN

Half a dozen of these handsome birds were received and fed on boiled rice and minced raw meat. (Dodoma, vi. 26.)

*FRANCOLINUS HILDEBRANDTI FISCHERI Reichenow

It was a surprise to have a couple of these large francolins brought in from the Dodoma district. Later I was almost certain I saw several on the road between Saranda and Kilamatinde. The food supplied them was similar to that provided for the last species. (Dodoma, vi. 26.)

FRANCOLINUS SEPHAENA GRANTII Hartlaub

GRANT'S CRESTED FRANCOLIN

More than 50 of these little partridgelike francolin were brought in. They took to captivity very naturally, though when confined in boxes—perhaps because of overcrowding or dietetic deficiency—they picked the feathers off each other's heads and necks till they were quite bare. When turned out into a run they ceased this vice. For the first few days in the run, however, many of them poked their heads against the wire netting until they bled all round the bases of their beaks. A month later some of them had scratched a hole under the wire netting and strayed out to the larger inclosure surrounded by piled-up thorn bush. Here a score of them were discovered, scratching and feeding, by a native whose sudden appearance caused them to rise in a covey and fly over the 6-foot high inclosure away to the open thorn bush. The astonishing thing was that at sunset most if not all of them flew back into the thorn inclosure and were found running round their wire-netted "home," trying to get in.

With three exceptions all were recaptured the same night; of the others, one was killed and eaten by some unknown carnivore; the remaining two were caught next day. (Dodoma, vi. 26.)

Three days ago disease appeared among these francolin, but does not seem to be spreading to the bustard, guinea fowl, or other occupants of the run. On the first day two died, yesterday six, to-day four. It appears to be an infection of the mouth which makes them disinclined to feed; this is followed by blindness in one or both eyes. (Dodoma, 14. viii. 26.)

Grant's francolin are very plentiful here and have astonished me by the way they will remain squatting in the grass. On one occasion I paused with two natives to examine a herd of giraffe. We crouched in short grass for five minutes, and it was only as I rose to go that a brace of bush fowl whirred away. The whole time they had been within 4 feet of us. The stomach contents of two birds were examined and found to chiefly consist of small reddish and very hard seeds, together with some green matter and an admixture of insects' (? termites) legs. (Saranda, 14. vii. 26.)

EUPODOTIS CANICOLLIS CANICOLLIS (Reichenow)

WHITE-BELLIED KNORHAAN

Shot a cock calling at 9 o'clock in the morning. (Nzingi, 26. v. 26.)

A fine bird in beautiful condition purchased this week is doing well on chopped meat. (Dodoma, 7. viii. 26.)

LISSOTIS MELANOGASTER (Rüppell)

BLACK-BELLIED BUSTARD

Three birds brought in are feeding exclusively, as far as one can see, on minced meat. (Dodoma, vi. 26.)

COLUMBA GUINEA GUINEA Linnaeus

SPECKLED PIGEON

Common on the rocky kopjes in the vicinity of the town; owing to their depredations in the gardens of the natives a battue was organized some few years ago and their numbers considerably reduced. They seem hardy enough in captivity, eating "mtama" and "mweli", but doves can not be confined in the same cage, as the pigeons peck them to death. Even members of their own species are liable to attack if introduced into a cage of well-established birds. This happened to two pigeons brought in from Kondoa Irangi on July 12, 1926. (Dodoma, vii. 26.)

A speckled pigeon was twice flushed from its nest in a hole in a branch of a baobab perhaps 30 feet from the ground. (Saranda, 12. vii. 26.)

Two nests, on which the hens were sitting, were built on top of posts in the "boma"; one examined held two eggs. (Kilamatinde, 20. vii. 26.)

TURTUR CHALCOSPILOS CHALCOSPILOS (Wagler)

EMERALD-SPOTTED GROUND DOVE

Many individuals were taken around Dodoma; a hardy species.

OENA CAPENSIS CAPENSIS (Linnaeus)

NAMAQUA DOVE

I disturbed a Namaqua dove building at Dodoma early in July. A nest containing two fresh eggs was taken by Salimu on August 28, 1926. An egg laid by a captive bird at the same time measures 20 by 13 mm.

Our first experience with these birds was disappointing, as only one hardy male survived on a diet of "mtama." Later in August these doves began flocking and great numbers might daily be seen feeding on the ground about the house. The natives brought in quite a number and I put these on a diet of "uwele," the seeds being threshed from the head. Though this food did not seem ideal, many of the birds appear to be subsisting on it, though a month is rather too short a time to make sure that it will suffice. (Dodoma, 31. viii. 26.)

STIGMATOPELIA SENEGALENSIS SENEGALENSIS (Linnaeus)

LAUGHING DOVE

This, the commonest dove in the territory, was captured in great numbers at Dodoma and Kondoa Irangi. Only "mtama" and water were supplied them. When overcrowded they pick the feathers off each other's heads.

A nest containing two young was found at Dodoma in June.

STREPTOPELIA DECIPIENS PERSPICILLATA (Fischer and Reichenow)

MASSAI MOURNING DOVE

I found five nests of this species in bull's-horn acacia thorn standing in water in the large swamp. Each nest was 5 feet from the ground, which was approximately 2 feet under water. Typical doves' nests built in crotch of main trunk.

One nest had a single fresh egg; the second and third fresh clutches of two; the fourth contained two eggs very different in shape, one was fresh and the other held an embryo; the fifth nest held two hard-set eggs, which I left. (Nzingi, 26. v. 26.)

Another egg laid by a captive bird in August measured 30 by 25 mm.

In captivity they were given "mtama" and water, on which they did well. (Dodoma, 5. viii. 26.)

STREPTOPELIA CAPICOLA TROPICA (Reichenow)

EAST AFRICAN RING-NECKED DOVE

Not so common at Dodoma as the other species, but a dozen or so were brought in and throve on a "mtama" diet.

TRIGONOCEPS OCCIPITALIS (Burchell)

WHITE-HEADED VULTURE

Brought in by an Mgogo native who had snared it the previous day. Almost immediately after arrival it took meat from forceps proffered by Haweis, though it was in a very small cage pending the making of a specially large one. It gulped down water as soon as it was put into the cage. (Dodoma, 3. vii. 26.)

MELIERAX POLIOPTERUS Cabanis

EAST AFRICAN CHANTING GOSHAWK

Salimu found a single nestling on a kopje at this place; it fed well on scraps of meat, but during my absence at Saranda in July it died and was replaced in the collection by another nestling taken near Dodoma, which never gained the full use of its legs, so I had to kill it. (Kikombo, vi. 26.)

Two full-grown birds in immature plumage were brought in during the latter half of this month, but did not agree in the same cage and had to be separated. (Dodoma, vii. 26.)

MELIERAX GABAR (Daudin)

GABAR GOSHAWK

Two of these birds were bought during July—cock and hen. The day before the latter was received the former escaped from its cage while it was being cleaned. The hawk flew out of the window and I never expected to see it again, but in the afternoon it returned, and, flying in at the door, sat on the floor in front of its cage, in which it was replaced without much difficulty. (Dodoma, vii. 26.)

A male shot at dusk had its stomach distended with meat, while a single black Hippoboscid fly was found among its feathers. (Saranda, 14. vii. 26.)

AQUILA RAPAX RAPAX (Temminck)

TAWNY EAGLE

A locally caught bird brought in to-day was placed in the same cage as another received from Kondoa Iranga on October 13, 1926. Both immediately erected their feathers with a very handsome effect, then the newcomer fell to on a plate of chopped meat. Rats and birds, however, were much more appreciated than meat. (Dodoma, 15. viii. 26.)

BUTEO RUFOFUSCUS AUGUR (Rüppell).

AUGUR BUZZARD

A single individual was brought in by a native; the species is tolerably common here in the vicinity of the kopjes.

The bird did well on a meat diet. (Dodoma, viii. 26.)

MILVUS MIGRANS PARASITUS (Daudin)

AFRICAN KITE

It is curious that only one representative of so common a species should have been taken, but such was the case, our solitary kite being sent in from Shinyanga by Mr. Carnochan.

ELANUS CAERULEUS CAERULEUS (Desfontaines)

BLACK-SHOULDERED KITE

Three nestlings were brought in and fed by Haweis on scraps of meat until they grew into fine birds, which kept themselves in beautiful condition. (Dodoma, 16. v. 26.)

Feeding time causes them to screech vociferously, raise their wings and ruffle their plumage even at this late date—July 6—when they look like adult birds, except for the immature mottling retained on breast and wings.

FALCO BIARMICUS BIARMICUS Temminck

SOUTH AFRICAN LANNER

An adult rufous crowned falcon arrived in the humiliating position of being crammed into a small chicken crate or native basket. For three days it refused food, though two rats were given it on arrival; then, finding the hunger strike of no advantage, it settled down to a diet of rats, small birds, or pieces of bullock meat which it seized upon with no delay or reluctance whatever. (Dodoma, 27. vi. 26.)

BUBO AFRICANUS AFRICANUS (Temminck)

SPOTTED EAGLE OWL

A bird brought in early in the week refused all food for three days, as far as one could see; then began eating rats. (Dodoma, 7. viii. 26.)

OTUS LEUCOTIS GRANTI (Kollibay)

SOUTHERN WHITE-FACED SCOPS OWL

Early in the month two downy nestlings were brought in which throve remarkably under Haweis' care. They were fed on fragments of rats and small birds or when these failed on scraps of raw bullock meat. By the end of the month they were able to tear up their own food.

At first these young birds were rather a noisy nuisance at night as they scrambled about on the wire netting and called, but gradually they settled down into a well-fed and somnolent respectability. (Dodoma, vi. 26.)

An adult brought in toward the end of the month refused to feed and though it was fed artificially for several days it succumbed on July 3. (Dodoma, vii. 26.)

TYTO ALBA AFFINIS (Blyth)

AFRICAN BARN OWL

A single bird received which frequently feeds at midday. The cry of this species was often heard around the house during May and June. (Dodoma vii. 26.)

Ten birds were brought in but are not feeding well on meat, though I have observed one eating in the daytime. Rats and a Grant's francolin were eaten readily enough, but it is difficult to obtain a sufficient supply of rats. (Kondoa Irangi, 13. vii. 26.)

POICEPHALUS MEYERI MATSCHIEI Neumann

EAST AFRICAN BROWN PARROT

A single locally purchased bird thrives. It is strange that more are not caught by the natives for they are common up and down the line, though not at Dodoma itself. Offering the munificent sum of 1 shilling for a bird has had no results. (Dodoma, vii. 26.)

AGAPORNIS PERSONATA Reichenow

YELLOW-BREASTED LOVE BIRD

Native name.—Quinzi (Chigogo).

When at Nzingi in May (24–26) a few of these birds were sleeping under the galvanized-iron roof of the station, having pecked out grooves in the supporting beam so as to facilitate their ingress and egress. Nests were observed, though these were probably old ones.

Hearing that love birds were numerous at Kikombo I sent Salimu down and he returned with half a dozen. Contrary to my previous experience they are very hardy if provided with heads of "mtama," from which they pick the seeds. They are no trouble to look after as they only need "mtama" and water. A perch in their cage is rather though not altogether superfluous, as at night they huddle into a corner in conformity with their similar habit, when in a wild state, of sleeping in holes in trees. They clamber about on the wire netting front of their cage more than on their perch and manage to keep themselves beautifully clean. The peck of one of these miniature parrots is to be respected, as it will draw blood.

While they are not rare at Dodoma itself, they are by no means common, for not more than half a dozen will be seen in any one day's walk. The few birds brought in during May and June died, owing to the treatment they had received at the hands of their Wagogo captors. (Kikombo, east of Dodoma, vi. 26.)

AGAPORNIS FISCHERI Reichenow

FISCHER'S LOVE BIRD

Very hardy in captivity, feeding like the last, adepts at escaping, and also in using their beaks to good effect. (Mbulu, near Arusha, v. 26.)

CORYTHAIXOIDES (CHIZAERHIS) LEUCOGASTER (Rüppell)

WHITE-BELLIED GOAWAY BIRD

A pair of young birds were brought in to-day; they were just fledged and apparently snared by the leg, for each had a leg broken or dislocated, so I promptly killed them. Two younger birds taken from the nest and brought in a week ago are doing well on papaw and banana (?) and rice. (Dodoma, 27. vi. 26.)

Died a month later.

An adult brought in four days ago had its leg strained or otherwise injured, presumably by the snare; it never recovered. (Dodoma, 7. viii. 26.)

CENTROPUS SUPERCILIOSUS LOANDAE C. Grant

CENTRAL AFRICAN WHITE-BROWED COUCAL

LAMPROMORPHA KLASSI (Stephens)

WHITE-BREASTED EMERALD CUCKOO

INDICATOR INDICATOR (Sparrman)

BLACK-THROATED HONEY GUIDE

TRICHOLAEMA LACRYMOSUM LACRYMOSUM Cabanis

SPOTTED-FLANKED BARBET

None of the foregoing survived many days. The single coucal from Bahi had had its flight and tail feathers plucked out; the honey guide seemed ill. A pair each of the emerald cuckoos and barbets were brought in.

TRICHOLAEMA DIADEMATUM MASSAICUM (Reichenow)

MASSAI RED-FRONTED BARBET

Two birds, when brought in to-day, promptly attacked some papaw fruit which was placed in their cage. (Dodoma, 5. vii. 26.)

But, like their predecessors, did not survive long. (Dodoma, 14. vii. 26.)

TRACHYPHONUS EMINI Reichenow

EMIN PASHA'S BARBET

Last month fully 50 of these handsome, cheery birds were brought in; they lived a few days, but invariably died. About the middle of June we refused to buy any more and then found that there were a dozen hardy survivors eating papaw, banana, tomatoes, and rice. The reason for the grievous mortality may be attributed to the mode of capture; these birds sleep, and are said to nest also, in burrows with a vertical shaft. The natives pour water into these holes until the half-drowned occupants are forced to emerge. This must naturally take place either late at night or in the early morning, when it is very cold at this altitude (3,700 feet). As these birds feed readily enough when brought in, one may reasonably suppose their subsequent death is due to chill. They are extraordinarily active, and it is a matter of no little difficulty to open a cage without one or more escaping.

As mentioned elsewhere,[4] I once found this species nesting in a hollow tree at Dodoma, but as such are scarce in thorn scrub, and

[4] Proc. Zool. Soc. 1922, p. 853.

the bird is very abundant, it seems highly probable that the species does nest in the ground. It brings to my recollection a statement made by Mr. D. W. Bisshop, in a letter to the game warden, which was written from somewhere in the vicinity of the Pare Mountains. He said that while walking along the road he was surprised to see a bird about the size of a thrush, but which he thought was a woodpecker, alight in the road and vanish from sight. On reaching the spot he found a vertical hole in the flat ground and on applying his ear to the entrance could distinctly hear the cheeping of nestlings.

Of course such a mode of nesting is only feasible in a dry region where the absence of rain may be depended on. (Dodoma, vi. 26.)

COLIUS MACROURUS PULCHER Neumann

BLUE-NAPED COLY

Great numbers of these handsome little long-tailed mouse birds were brought in; at the time of writing we have 60 in one cage. They do not make good cage birds, owing to their habit of clustering together and dropping over one another's plumage until they get into an appalling mess. In an aviary they would doubtless keep clean and look more attractive, as they are excessively hardy. It was a pitiful sight to see these docile little birds brought in crowded together in a gourd ("kibuyu"), frequently their feathers hopelessly messed up with bird lime ("ulambo") and their long tails missing. Explaining to the dense Wagogo youngsters seemed useless until we refused to purchase any birds but those in good condition. The numbers fell off greatly but in a couple of weeks 90 per cent of the birds brought in were in excellent shape.

They crave papaw, which they fall upon greedily and distend their crops until these look like so many rubber balloons. The food soon passes through them and I doubt if it is really good for them. Under natural conditions I have seen them feeding on a tree burdened with a crop of hard berries. In captivity they become remarkably tame, rarely attempting to escape, and allowing themselves to be freely handled. Their whistling cry at the sight of food was a characteristic noise at feeding time.

Plenty of sand in the cages is a necessity, and this should be changed daily. (Dodoma, vi. 26.)

CORACIAS CAUDATUS CAUDATUS Linnaeus

LILAC-BREASTED ROLLER

Two of these birds were brought in during the month; they did not take very kindly to meat immediately, being rapacious over their natural diet of grasshoppers, which they could hardly ever view with indifference.

Large brown cockroaches were seized with avidity when presented to them, and fortunately these insects were by no means uncommon, so that on the average the rollers got at least one a day.

When both were hungry they were quarrelsome and pecked each other viciously, uttering their harsh and noisy cries while they fought. The bird is distinctly uncommon at Dodoma, probably because grasshoppers are not present in sufficient numbers during the whole year, as I fancy they would be at Morogoro, where this species is so abundant. Nesting sites are also a possible difficulty in this thorn bush country except in areas where baobabs are numerous. (Dodoma, vi. 26.)

LOPHOCEROS MELANOLEUCUS MELANOLEUCUS (Lichtenstein)

CROWNED HORNBILL

LOPHOCEROS DECKENI (Cabanis)

VON DER DECKEN'S HORNBILL

Neither of these birds occur commonly at Dodoma, though both may be seen occasionally. Half a dozen of the former and about 50 of the latter were brought in but did not do well in captivity, nor is this entirely attributable to the fact that in most cases the long tail feathers had been plucked out by their captors.

Von der Decken's seemed hardier in captivity than the crowned hornbill, but it is rather difficult to be certain owing to the disproportion in their numbers. It is useless to place their food in a plate; it must be in a bowl into which they can thrust their beaks; even then they wantonly throw most of it about the cage and eat but a small proportion. Chopped meat formed their principal food and was superimposed on half a bowl of rice, of which they took but little. Papaw cut transversely and placed in each cage was pecked at a good deal. Seeing flocks of these birds feeding in the "mtama" fields at Saranda—from which they rose like flocks of sparrows—I supposed "mtama" would be acceptable to them, but this was not the case.

Their chief characteristic was their endless hammering at the sides and netting of their cages. Double-wire netting would only survive the attack for a day, for as soon as a strand was cut they would adroitly twist the loose ends about and soon enlarge the hole, through which they would escape. Fully a dozen adventurous birds got free but were recaptured.

An unwary hand put into their cages to place food or remove an empty water dish could count on receiving a most painful jab from the point of a bill or else a tweak no less unpleasant.

Grass instead of sand on the floor of their cage enables one to recover the scattered meat which they throw about; it can then be used for feeding to the ducks. (Dodoma, vii. 26.)

RHINOPOMASTUS MINOR CABANISI (Defilippi)

WHITE NILE SCIMITAR BILL

A bird in fine condition was brought in on July 3. It is the second in two months, the first not being accepted. It was not at all shy and threw its minced meat all over the place. I can not definitely say it ate any, though I think it did. Three days later this bird died. (Dodoma, 9 vii. 26.)

EUROCEPHALUS RUEPPELLI BOHMI Zedlitz

TANGANYIKA WHITE-HEADED SHRIKE

This species, so common in the thorn bush around Dodoma, would not feed on minced meat and was therefore released. (Dodoma, viii. 26.)

UROLESTES AEQUATORIALIS Reichenow

EQUATORIAL LONG-TAILED SHRIKE

A pair of these birds were collected for locality record and their stomachs found to contain grasshoppers. Fairly common. (Saranda, 14. vii. 26.)

LANIARIUS FUNEBRIS FUNEBRIS (Hartlaub)

LARGE GRAY-BLACK SHRIKE

One or two brought in each month, none of which survived. (Dodoma, viii. 26.)

CORVUS ALBUS P. L. S. Müller (SCAPULATUS Authors)

WHITE-BREASTED CROW

These handsome crows are the most conspicuous large birds in Dodoma town and vicinity. They frequent the garbage dumps and slaughterhouse and in return for their usefulness as scavengers are protected. By offering sixpence each for them a steady stream of birds, at the rate of one or two a day, came in, until we had 33 at the end of the month and refused to purchase any more.

They are hardy in captivity, eating raw meat or dead birds and rats with avidity. Before giving them their favorite fare, a plate of rice would be put in each cage of crows and they would take it—apparently under protest, as the plates were very rarely cleaned up. Grass and not sand is advisable in the cages, otherwise the birds drop their meat in the sand and either refuse to eat it or eat it covered with sand, which can hardly be good for them. (Dodoma, vi. 26.)

CORVULTUR ALBICOLLIS (Latham)

WHITE-NECKED RAVEN

What has been said of the white-breasted crow's diet applies equally well to that of these larger birds, easily distinguished from the former by the absence of white on the breast. It is a good plan to furnish both species with a skull, some ribs of meat, or other bones

at which they can pick during the day between their regular feeding hours of 9 o'clock in the morning and 5 o'clock in the evening. It is unfortunate that in the confines of a cage both birds mess up their handsome black plumage by going beneath the perches when their companions are above them. To make them more presentable, Haweis gave the six ravens a bath and washed their plumage with soap and water. In 24 hours, however, it was a case of "as you were."

They are not as numerous as the crows, but about sunset every evening considerable numbers may be seen circling about the larger kopjes in the vicinity of the town. The sheltered ledges of rock where they roost were distinguishable, but I came across no nests either old or new. (Dodoma, vi. 26.)

BUPHAGA ERYTHRORHYNCHA ERYTHRORHYNCHA (Stanley)

RED-BILLED OXPECKER

Native name.—Nghasi (Chigogo).

A fledgling, the sides of whose bill are still soft, has been brought in and eats minced meat with relish, clamoring for it and taking it from my fingers. After the arrival of the greater kudu from Kondoa Irangi a pair of adult oxpeckers might be seen on it every morning in the wall-inclosed yard where it was kept. (Dodoma, 7. viii. 26.)

SPREO SUPERBUS (Rüppell)

WHITE-BANDED GLOSSY STARLING

One or two birds received in May did not live, for some inexplicable reason. Half a dozen now in the collection are fed on minced meat, papaw, and boiled rice. Flocks of these starlings were to be seen feeding daily on a rubbish dump during May and June. (Dodoma, vii. 26.)

LAMPROCOLIUS SYCOBIUS PESTIS van Someren

SOUTHERN GLOSSY STARLING

Some 40 birds received during the last four months are fed like the last-mentioned species, with excellent results. They have very large appetites and it is necessary to feed them several times a day if their plates are empty. In the confinement of a cage their beautiful plumage is messed up by birds sitting on perches above them, so it is well that they should not be overcrowded. Plenty of sand in the bottom of the cage is a necessity and should be changed daily. (Dodoma, viii. 26.)

COSMOPSARUS UNICOLOR Shelley

OLIVE LONG-TAILED GLOSSY STARLING

Half a dozen specimens received, of which only two survived; they were kept with the southern glossy starlings. (Dodoma, vii. 26.)

ONYCHOGNATHUS MORIO SHELLEYI Hartert

GREAT RED-WINGED STARLING

It was a surprise when one of these birds was brought in, but later I found them plentiful on a kopje to the west of the town. The bird did not live. (Dodoma, vi. 26.)

BUBALORNIS NIGER NYANSAE (Neumann)

BLACK-WINGED CORAL-BILLED WEAVER

Three birds in prime condition were brought in about the middle of the month. They showed no embarrassment in captivity, retained a pride in their personal appearance, and fed well upon rice and "mtama." (Dodoma, vi. 26.)

DINEMELLIA BOHMI (Reichenow)

BOHM'S GIANT WEAVER

Two received, but did not live. (Dodoma, vii. 26.)

SPOROPIPES FRONTALIS EMINI Neumann

EMIN'S SCALY HEADED FINCH

HYPHANTURGUS NIGRICOLLIS MELANOXANTHUS Cabanis

COAST BLACK-MANTLED YELLOW WEAVER

TEXTOR NIGRICEPS NIGRICEPS (Layard)

BLACK-HEADED WEAVER

AMADINA FASCIATA ALEXANDERI Neumann

CUT-THROAT FINCH

QUELEA SANGUINIROSTRIS ? CANDIDA Friedmann

SOUTHERN MASKED WEAVER FINCH

PYROMELANA HORDEACEA SYLVATICA Neumann

RED-CROWNED BISHOP BIRD

VIDUA species

WHYDAH

GRANATINA IANTHOGASTRA IANTHOGASTRA Reichenow

PYTILIA KIRKI Shelley

EAST AFRICAN FIRE-THROATED FINCH

LAGNOSTICTA species

CRIMSON FINCHES

All the foregoing species of weaver birds were placed on a diet of "mtama" or "uwele" and all save the last survived in considerable numbers. It will be readily understood that where birds are carried in the hot hand of a native their chance of survival is small.

One day about 80 bishop birds were brought to us in crates and apparently all right, though the men that brought them were fagged out and said they had had an eight-hour walk. The birds fed well, but next day about 10 were dead and many more on succeeding days until their numbers were reduced to 40.

URAEGINTHUS BENGALUS CYANOCEPHALUS (Richmond)

BLUE-HEADED BLUE WAXBILL

A bird flew off its nest containing three fresh eggs. (Dodoma, 15. v. 26.)

Another flew from a pendant weaver's nest of the short-spouted type (*Ploceus* species) and in it were three waxbill eggs and one or more young. Yet another bird was flushed from its clutch of eggs, in a typical nest situated in an acacia thorn. (Dodoma, 18. v. 26)

A number of these birds were caged and did very well on a diet of "uwele" heads. (Dodoma, 31. viii. 26.)

PASSER GRISEUS SUAHELICUS Neumann

COASTAL PALE-BELLIED SPARROW

A nest with young was found in that of a swallow's (*H. unitatis abyssinicus*) under the station roof where several other sparrows also had their nests. (Nzingi, 25. v. 26.)

Many nests containing young under the roof of our house here. (Dodoma, 5. v. 26.)

Fledglings invariably died in captivity. Adults do well on a diet of "mtama" and "uwele." (Dodoma, viii. 26.)

SERINUS DORSOSTRIATUS DORSOSTRIATUS Reichenow

These finches do not stand captivity at all well, none surviving more than a week. (Dodoma, viii. 26.)

SERINUS ICTERUS subspecies

LITTLE YELLOW SERIN

A number of these birds lived well, while others, probably maltreated before being brought in, died. Two nests, each containing three young, were found at Dodoma on May 14, 1926. One brood took to wing when disturbed.

EREMOPTERYX LEUCOPAREIA (Fischer and Reichenow)

RED-CAPPED FINCH LARK

A female red-capped finch lark was shot off its nest at Dodoma, May 19, 1926. The latter contained three semi-incubated eggs measuring 17 by 13 mm.; the ground color of the eggs was white, upon which were superimposed olivaceous-brown specklings; these covered

the whole surface but varied in intensity. The nest—it hardly merits the name—was about 2 inches in diameter but without bottom; the eggs, resting on the ground, were surrounded with a neat little circle of fibrous grass and rootlets with a few heads of grass beside it. The nest appeared to be built in a depression, but this was not the case, as it was only among grass roots at the base of a little tussock on more or less open and bare ground.

MOTACILLA AGUIMP Dumont

AFRICAN PIED WAGTAIL

One of these wagtails left the station roof at dawn; it was apparently nesting there. (Nzingi, 25. v. 26.)

An African pied wagtail regularly frequented the veranda of Mr. Robbie's house, where, to my surprise, it occupied itself in picking up crumbs. (Saranda, 16. vii. 26.)

A one-legged bird might often be seen feeding about the "boma"; a month later I saw one in the same condition, and presumably the same bird, feeding near our house, which is half a mile from the "boma." (Dodoma, viii. 26.)

CHLOROCICHLA FLAVIVENTRIS subspecies

YELLOW BULBUL

During June, July, and August a great many of these birds were brought in and the majority proved hardy, thriving on a diet of papaw and rice. If there was a delay in giving them their food after they had caught sight of it, they thrust their heads through the netting and piped vociferously. (Dodoma, viii. 26.)

PYCNONOTUS TRICOLOR MICRUS Oberholser

KILIMANJARO YELLOW-VENTED BULBUL

These birds do well for a time on a diet of papaw and boiled rice and then usually die, without a doubt owing to some deficiency in the diet. (Dodoma, viii. 26.)

CICHLADUSA GUTTATA RUFIPENNIS Sharpe

LAMU SPECKLED BABBLER

Two or three of these lovely little songsters were brought in but refused all food. (Dodoma, vi. 26.)

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The bringing in of sunbirds and warblers was strongly discouraged, as their chances of survival were remote.

REPTILIA

It is hoped that the following notes may form a fairly exhaustive list of the reptiles found in the immediate vicinity of Dodoma township.

CHELONIA

KINIXYS BELLIANA Gray

BELL'S HINGED TORTOISE

Native names.—Furgobi (Chigogo); Furgobi (Kiswahili).

Decidedly scarce in the Dodoma district; one example was brought in from Kongonda, 9 miles outside the township. Only four were caught during as many months. Several others came from Mbulu in the Arusha district. They feed well in captivity and took papaw quite readily.

TESTUDO PARDALIS Bell

LEOPARD TORTOISE

Native names.—Malugangi (Chigogo); Furgobi (Kiswahili).

Also by no means common, though apparently more abundant than Bell's tortoise, as over a dozen were brought in from the country around Dodoma. A very large one was taken on the railway line at Nzingi, another at Irazo. Most of the 34 individuals brought home by the expedition came from the Shinyanga, Arusha, and Kondoa Irangi centers.

One of the Arusha tortoises was the largest Tanganyika Territory specimen I have yet seen. A Tabora tortoise laid two eggs, on August 5 and 25, respectively. It is only presumed that it was the same reptile laid both. These eggs measured 38 by 40 mm. and 40 by 40 mm.

A tick (*Amblyomma marmoreum*) was taken from one of these tortoises.

TESTUDO TORNIERI Siebenrock

SOFT-SHELLED LAND TORTOISE

Testudo loveridgii BOULENGER, 1920, Compt. Rend. Acad. Sci., Paris, vol. 170, p. 264.

Some interesting additions to our knowledge of this reptile resulted from the expedition. It was collected at Dodoma and Tabora (from which *T. loveridgii* was first recorded), but an individual was also taken near Kondoa Irangi, 105 miles to the north of Dodoma; two from Mfilima, two from Kikombo, both the latter localities comparatively near Dodoma, and Kibakwe, about 80 miles to the southeast and not more than a dozen miles (if my memory is correct) from Ikikuyu, the type locality of *Testudo procterae.* The offering of a

large reward caused the natives to scour the countryside within walking distance of Dodoma and demonstrated that the creature is not really rare, though I collected only three individuals in as many afternoons spent in searching for them; all three were together, some 5 feet up in a fissure from which it took us an hour to dislodge them.

A male soft-shelled tortoise unsuccessfully endeavored to mate with a female Bell's hinged tortoise (which shared the same inclosure with many of the former) for the space of five minutes. She continually walked away. (Kilosa, 5. ii. 1921.)

At 9 o'clock in the morning, on the top of a large sloping rock measuring about 50 by 20 feet, I found two small soft-shelled tortoises basking in the sunshine. A little later a third was discovered nibbling some very dry grass on the top of the same kopje; all were in a well-nourished condition. Two natives and myself hunted for an hour without finding any more. In length and breadth they measured 94 by 78 mm., 80 by 68 mm., and 70 by 65 mm. They had divided supracaudals, though one was a little doubtful. (Tabora, 18. xi. 21.)

Dr. Otto Wettstein,[5] after a very thorough comparative study of a topotype *T. loveridgii* with the type and other examples of *T. tornieri* which was based on a slightly aberrant individual, arrived at the conclusion that the former must now be included in the synonymy of the latter, an opinion which the present series fully corroborates.

In a series of 25 tortoises, one example (No. 23009, Mus. Comp. Zoöl.) has a depth of 21.6 per cent of the length, a condition very close to that of the type of *T. tornieri*, where it is 21.7 per cent. The range in this series is from 19.5 to 34.6 per cent; to give the average is of little use, as it is entirely dependent on whether the specimens are young or adult. The nearest specimen in actual length and breadth to the type of *T. tornieri* is No. 33004, which measures 162 by 114 mm., yet its depth is 24 per cent as against 21.7 per cent in the type of *T. tornieri*, which measured 161 by 110 mm. In the whole series the range of breadth in relation to length is 69.1 per cent to 94.2 per cent. The variation in relative breadth and width is truly astonishing and the actual specimens need to be seen before it can be fully appreciated as figures give but a poor idea of its extent.

These dimensions are based on measurements of the greatest length and breadth of the whole shell, obtained by placing the tortoise between two blocks of wood. Miss Procter's measurements were taken across mid-body, while usually the greatest width, as well as depth, is about the region of the insertion of the hind limbs.

Doctor Wettstein has pointed out that the type of *T. tornieri* is aberrant in possessing 9 costal shields besides other variations from the normal. It had 4 costals on one side and 5 on the other and an

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[5] Zool. Anz., 1924, vol. 60, Heft 9/10, pp. 201–8.

extra vertebral. Similar aberrations are found in the present series from Dodoma of which two tortoises had 4 costals on one side and 5 on the other; two tortoises had 6 vertebrals; five had 12 marginals on either side instead of 11; in another the lateral marginals are narrow and upturned, having exactly the appearance of roofing gutters. In several the supracaudals are undivided. Some have very strongly embossed plates.

The largest individual, a female, measures 177 mm. in length, 131 mm. in breadth, and 40 mm. in depth, being 17 mm. longer but only 1 mm. broader than the largest previously known specimen, which was also a female. The Kondoa Irangi male measures 152 mm. long by 115 mm. broad.

Two females which died in July were presumably egg-bound, for each was found to contain a single large egg. Just as we were loading the crate of tortoises into the train on September 2, I found a fresh egg had been laid. As there were no other species of tortoises in this crate, it can not but have been that of a soft-shelled tortoise. Unfortunately it was placed for safety under a near-by bush and never recovered. It is quite certain, however, that this species lays but one very large egg.

PELUSIOS NIGRICANS CASTANEUS (Schweigger)

BLACK WATER TORTOISE

Native name.—Malfuti (Chigogo).

Some 50 of these tortoises were purchased from natives. Fourteen came from Mukwese, others from Mtita's near Dodoma.

The largest of this fine series, a male (?), only measured 175 mm. in length by 122 mm. in breadth.

I questioned many natives as to whether they attained a greater size in the Dodoma district, but all were quite definite that they had never seen larger. Compared with a specimen in the Museum of Comparative Zoölogy (M. C. Z. No. 18163) from the Ruaha, Tanganyika Territory, which measures 368 by 248 mm., these Dodoma examples are only dwarfs. Is it possible that the arid nature of the country and the small and scattered water holes are responsible for this state of affairs? Yet there are large sheets of water such as at Nzingi and Bahi where one would expect them to reach larger dimensions.

PELOMEDUSA GALEATA (Schoepff)

COMMON AFRICAN WATER TORTOISE

Natives name.—Malwala (Chigogo).

Over a hundred of these fresh-water tortoises were purchased. Most of them came from the immediate vicinity of Dodoma township where they are very common. I have seen one sunning itself on the edge

of a water hole (where clothes are frequently washed) almost in the town. Others came from Mtita's, Nzingi, Mukwese, and Mbulu.

The largest male measured 197 mm. long, and 128 mm. broad; the largest female 160 mm. long by 130 mm. broad.

Like the black-water tortoise they lived well on chopped meat fed to them in a large tank of water. During July, however, either overcrowding in the tank or some seasonal instinct warning them that it was time all small water holes had dried up caused them with one accord to clamber out and pile themselves inside the wire netting of their inclosure. Putting them back was of no avail and for a week they stayed exposed to the cold winds prevalent at night, until I removed them indoors and packed them into crates containing straw. This, however, proved fatal to the very small ones, a number of whom succumbed.

OPHIDIA

At my request, Mr. Carnochan, who was purchasing snakes in the Shinyanga subdistrict, sent down two of the Wanyimwezi snake-catchers called "Wayeye." These youths, named Gurukezi *bin* Umbwa and Kifinda *bin* Maganga, were not full initiates into the mysteries of their art. I intended to have gone fully into the question of their treatment of snake bite, but as I found Mr. Carnochan had already collected much matter relative thereto which he purposes publishing I let the matter drop.

That there is something in their knowledge of snake cures I still believe, though there is a considerable admixture of ignorance and charlatanry in their lore, but the fearless way in which they will handle Egyptian and spitting cobras is not a little astonishing. I have included in the following remarks sundry notes jotted down as given me by Gurukezi, with the approval of Kifinda, from which it will be seen that they have "cures" for the bites of many harmless species, which they believe poisonous.

The Chigogo names of reptiles should be accepted with reserve until checked over by some acknowledged Mgogo expert snake hunter. They were given me by a group of old men who would be as likely to confuse species as any similar group of Europeans called upon to name the reptiles of their neighborhood.

PYTHON SEBAE (Gmelin)

AFRICAN PYTHON

Native names.—Hatu (Chigogo); Satu (Kiswahili); Ngoi (Kikami).

The Wanyimwezi profess to divide the python into three species, employing the Kiswahili and Kisukuma "satu" for full-grown snakes, which they consider belong to a bush-dwelling species. Specimens ranging from 9 to 18 feet, and with a light spot on the head,

are alleged to be a rock and water snake and are known as "sawaka," while young or brightly colored pythons are referred to as "dilemma" and their habitat said to be the waterside.

As may be supposed in a district so poorly supplied with water as is that of Dodoma, pythons are restricted to those areas where permanent water can be depended upon. Thus the only specimen brought in alive came from Bahi and a skin from Kissako. Tracks were also seen at Nzingi and Manyoni. Fortunately, Mr. Carnochan was able to purchase a score of fine pythons in the Shinyanga area, at least 10 of which were over 10 feet in length and one which I personally measured, was 14 feet.

Ticks (*Aponomma laeve*) were removed from it.

BOAEDON LINEATUS Duméril and Bibron

BROWN HOUSE SNAKE

Native names.—Yamukulo (Chigogo).

Two specimens from Dodoma are a yellowish brown color, in conformity with such a desert habitat.

PHILOTHAMNUS SEMIVARIEGATUS (Smith)

BUSH SNAKE

Native name.—Nhanga (Chigogo); Yarudutu (Kinyamwezi).

Mr. Carnochan brought back one specimen from Manyoni which disgorged a gecko (*Pachydactylus bibroni*) when captured. It fed on common geckos (*Hemidactylus mabouia*) during the three months prior to embarkation.

CORONELLA SEMIORNATA (Peters)

SEMI-ORNATE SMOOTH SNAKE

Two females collected by Salimu at Kipetu in Manyoni subdistrict. Their measurements and formulae are well within the range of the species: (1) 460 mm.; 125 mm.; Sc. 21, V. 188, A. 1, C. 71, L. 8. (2) 493 mm.; 140 mm.; Sc. 21, V. 188, A. 1, C. 76, L. 8.

SCAPHIOPHIS ALBOPUNCTATUS Peters

Native names.—Ngolochetzi (Chigogo); Ipela (Kinyamwezi).

Two from Dodoma and half a dozen from Shinyanga.

One of the Dodoma specimens was killed in the kitchen of the geological department's headquarters; the other was brought in alive by a local Monumwezi snake catcher who had torn out its teeth, a fact he stoutly denied.

The largest male measures 1,155 mm. (949 + 206), and largest female 1,017 mm. (880 + 137), thus far surpassing any measurments given for

this species by Boulenger[6] or Schmidt[7] but not those of a Dahomey snake recorded by Chabanaud[8] as being 1,610 mm. in total length.

The ventrals in these males[9] are 192 and 197 as against a range of 185–189 in Schmidt's Congo series; in the single female they are 216 as against 216–224 in the Congo examples. Caudals in males 71–73 as against 64–69 (Congo); in female 54 as against 58–66 (Congo). It would rather appear as if Tanganyika Territory snakes may form an easterly race with more ventrals and caudals in the males than is the case with central African examples; without more material, however, it would be rash to draw too definite conclusions. Very few authors have given scale counts, and where they have done so they have usually omitted any reference to the sex; the literature of the species consists chiefly of located records.

Dorsal scale counts are all 27–25–21 in my three specimens as against 23–21–17 and 25–23–19 in the Congo series of seven snakes. Scales about eye, exclusive of the supraocular, are 6 or 7; temporals 4 to 6 in first row. Two superposed loreals in both Kizumbi snakes, an anterior and a posterior loreal in the Dodoma reptile. Upper labials 5–6, lower 9–10. In life these snakes were uniformly grayish, in alcohol they are grayish brown; no trace of the white or black spotting of the West Coast forms.

Gurukezi and Kifinda said that they had never been bitten by this species, but that they believed it to be very poisonous, one's skin becoming the color (gray) of the snake after being bitten. For treatment they employ a "dawa" (medicine) called "kilindelamagunda."

Needless to say, it is a perfectly harmless species, and these constitute the first East African examples I have seen. They did not eat in captivity, but drank deeply.

DASYPELTIS SCABER (Linnaeus)

EGG-EATING SNAKE

A very young one from Kikombo and a slough on the station at Nzingi.

CROTAPHOPELTIS HOTAMBOEIA (Laurenti)

WHITE-LIPPED SNAKE

One adult was brought in at Dodoma and I caught two young; one outside our headquarters, the other under the bark of a fallen tree at Mukwese, near Manyoni. Two of these snakes were bitten by an angry boomslang and both succumbed in a very short time. The

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[6] Boulenger, 1894, Cat. Sn. Brit. Mus., vol. 2, p. 254; 1896, Ann. Mag. Nat. Hist., ser. 2, vol. 16, p. 553.

[7] Schmidt, 1923, Bull. Amer. Mus. Nat. Hist., vol. 49, p. 91.

[8] Chabanaud, 1916, Bull. Mus. Hist. Nat., Paris, vol. 22, p. 372.

[9] Boulenger, 1896, Cat. Sn. Brit. Mus. vol. 3, p. 641, records a male from Ugogo (Dodoma district) as having Sc. 24, V. 194, C. 72.

South African name of red-lipped snake for this species is somewhat of a misnomer for East African specimens, as the lips are white in every individual I have seen. In the larger example there are three (not four) chin shields followed by the transversely enlarged ventrals; in the smaller snake many of these ventrals are divided; as a result there are seven pairs of chin or gular shields in this region. The latter specimen has eight labials (3d, 4th, and 5th enter eye) on the left side and nine on the right (4th, 5th, and 6th enter eye).

AMPLORHINUS NOTOTAENIA (Guenther)

One found on the threshold of the kitchen at Dodoma had probably been introduced in firewood. Length H. and B. 300 mm., tail 101 mm., Sc. 17, V. 170, A. 2, C. 75, L. 8 (4th and 5th enter eye).

RHAMPHIOPHIS OXYRHYNCHUS (Reinhardt)

SHARP-NOSED SNAKE

Native names.—Swaga (Chigogo); Simbi or Nzimbi (Kinyamwezi); Msanga (Kikami).

A very common species; about 20 were caught around Dodoma and 40 brought from Shinyanga.

Gurukezi states that the Wayeye only consider its bite slightly poisonous. Fed well on frogs (*Rana mascareniensis*) while in captivity. One laid 10 eggs between August 28 and 31; one of these measured 34 by 22 mm.

PSAMMOPHIS SIBILANS (Linnaeus)

HISSING SAND SNAKE

Native names.—Nyamkando (Chigogo); Yamuwe (Kinyamwezi).

A big series from Shinyanga subdistrict; none seen or brought in at Dodoma. Gurukezi, who seemed decidedly afraid of its teeth, said they bite freely when caught, and for the bite of the "nyulsenga," as they sometimes called it, they apply the leaves of the "lusenga" tree.

PSAMMOPHIS SUBTAENIATUS Peters

STRIPE-BELLIED SAND SNAKE

Native names.—Mlalu (Chigogo); Sangaraza (Kiswahili); Sangaraza (Kikami); Iruwassi (Kinyamwezi).

The Wayeye snake catchers applied two other Kinyamwezi names to this species, calling the pale type, so common in the Dodoma thorn bush, "mbalama" and the dark form "nyalwinzi"; a large series of the latter were obtained in the Shinyanga subdistrict; its plumbeous hue is strikingly different from that of the sandy-colored type. The latter may be seen on the embankments flanking the the railway between Dodoma and Nzingi.

Gurukezi said they considered its bite poisonous, though but slightly so, as there was only a little local irritation; for the bite they apply the leaves of the "kinyamalowa", a shrub about 5 feet in height.

PSAMMOPHIS BISERIATUS (Peters)

TWO-LINED SAND SNAKE

Native name.—Zokalugwagu (Chigogo).

The Wayeye are probably quite unacquainted with this species which hitherto I have only found in thorn bush steppe. They applied their names for *T. kirtlandii* and *D. typus* to specimens shown them, asserting that they were the young of one or the other.

This snake is very common at Saranda, where scarcely a day passed (July 14–23, 1926) without my disturbing one or two basking among the fallen leaves at the base of shrubs, into which they vanished with great rapidity. One had then to remain still and carefully scrutinize the bush, where presently the snake would be found either lying along a branch to which it had applied its whole length or with the anterior third of its slender body stiffened and projecting into space like a twig. One has but to examine the markings of one of these snakes to appreciate how remarkably well their cryptic coloring and slender habit simulate the twigs among which they take refuge. The scale formulae of four specimens were in no way unusual, Sc. 15, V. 148–155, A 2, C. 107–111, L. 8–9, with 4th, 5th, and 6th or 3d, 4th, and 5th entering the eye.

The stomach of one examined contained a large lizard (*Latastia longicaudata revoili*).

THELOTORNIS KIRTLANDII (Hallowell)

BIRD SNAKE

Native name.—Yangalukwe (Kinyamwezi).

The only bird snake received was brought in from Kondoa Irangi and died the following day. The species occurs at Mpapua in Dodoma Province. Gurukezi said they regard it "as poisonous as the mamba, death occurring in one minute if no medicine is used. However, it is not vicious and is frequently brought in with a load of firewood, remaining perfectly quiet until the load is thrown down; if trodden on it will bite."

DISPHOLIDUS TYPUS (Smith)

BOOMSLANG OR TREE SNAKE

Native names.—Yamuhando (Chigogo) for brown variety, Zokalugwagu (Chigogo) for young.

I came across only the brown form around Dodoma, where it was not uncommon; a big female was taken crossing the road at Kikuyu

one evening. The next day, August 28, 1926, this snake laid a single egg measuring 40 mm. in length.

Mr. Carnochan brought back a fine series of color forms from Shinyanga, including a salmon red, one that I do not recollect having seen before. He also gave me the Kinyamwezi names for these various colored varieties, which they, of course, consider distinct species.

Brown, "kalilelala"; brown and olive, "siana"; brown, and white spotted, "yangulukwe"—in Kikami, "lukukuru"; red, "kobokeyam-ulinga"; and green and black, "gurukezi"—in Kikami, "ngole."

I showed one of these last to a party of old Wagogo men and they called it "nyarudededi"; it is doubtful if it occurs in Ugogo.

APARALLACTUS LUNULATUS (Peters)

BLACK-HEADED SNAKE

A single individual found dead in the road between Manyoni and Mukwese. Sc. 15, V. 156, A. 1, C. 49, L. 7, (3d and 4th enter eye). This record extends the known range of the species much farther east. There is, however, an unrecorded specimen from the Rufigi in the game department collection at Kilosa.

NAJA HAJE (Linnaeus)

EGYPTIAN COBRA

Native names.—Kipara nunga (Kinyamwezi); Sakamala (Kikami. Six from Simui and two from Ibadakuri, both localities in the Shinyanga subdistrict. I was very much interested in these snakes, as they were the first living Egyptian cobras I had seen in Tanganyika Territory. All were over 6 feet long. They refused to eat food offered during the month they were at Dodoma prior to shipment.

Gurukezi states that this cobra only occurs in big forest, that they are vicious, and that the Wayeye consider their bite fatal.

NAJA NIGRICOLLIS Reinhardt

BLACK-NECKED SPITTING COBRA

Native names.—Nyamwiro (Chigogo); Sweela (Kinyamwezi); Kigau (Kikami).

For the young, showing well-defined red and yellow bands on underside of hood, the Wanyimwezi have another name—namely, "kawosia," and the Waswahili "kikanga."

I gather from a description given me by Mr. Hignell that this snake is occasionally found at Dodoma, though none was seen during the four months that I was there. At Saranda, however, I got two on successive days and one of these was the biggest cobra I had yet taken; it taped over 6 feet alive and I feel confident would be about 7 feet dead and properly straightened out.

This fine reptile was encountered in open maiombo forest and wriggled across our route. I gave chase and threw my stick at it as it speeded up; this caused it to raise its hood, but it came on (I had headed it off meantime), and being stickless I stepped aside; it passed me with a rush and went down a hole only a yard from where I had been standing.

Though flush with the ground this hole appeared to be part of some old termite galleries.

By means of a hoe I had the surrounding vegetation cleared in a 10-foot circle. This revealed another hole, which I plugged; then putting a long stick down the central shaft I stirred it around; in a matter of seconds up shot the cobra's head and it spat as I retreated. This occurred three times, but the snake refused to come out. Digging in the hard ground with the hoe disclosed the fact that it had retired into a side gallery. Out of this I poked it, but this only resulted in its taking refuge in another, where I was successful in pinning down its neck with a forked stick and taking it out. It spat between a dozen and twenty times, and its venom was in no way exhausted right to the end, for when putting it into the bag it nearly hit Salimu, who was holding the bag for me.

At 9.30 o'clock in the morning on the previous day I had seen the head of a black snake protruding from a knot hole in a maiombo tree, the hole was 5½ feet from the ground. Thinking it was either a *Dispholidus typus* or *Rhamnophis jacksonii*, and without giving *N. nigricollis* a thought, I walked up to within 4 feet, twiddling the fingers of my left hand while I imperceptibly approached my snake stick with the right to within 2 inches of his neck.

During this time my eyes were fixed on the oblique scales of a few inches of his neck, which confirmed my idea of a boomslang; also the head seemed much narrower than that of a cobra. I pinned him by the back of the neck against the side of the knot hole, but this being very smooth and the snake having plenty of purchase power he jerked his head free and disappeared into the hole, giving me as he did so a glimpse of white scaling on the throat. For the first time I realized the snake was a spitting cobra to whom I had been presenting my eyes as a target at a range of 4 feet.

I poked a wand 10 feet up inside the tree without effect, then got Salimu to cut away the earth, termites, and decayed wood which filled a hole at the base of the tree. Presently he thrust his bush knife into space and triumphantly announced the way clear. Poking with the wand had no effect, so we lit a smoky grass fire at the base of the tree, but very little smoke drew into the trunk, owing to the fact that the wind was unfavorable. Salimu raked out the smoldering grass and again poked his "panga" into the hole, then jumped back exclaiming "Tayari" (ready) as the cobra's tail flopped into view. I grabbed

this and pulled the owner down and out as he made haste to ascend the hollow trunk, but dropped him like a hot cake when his head came into view.

He made for the next tree, but pursuing I flicked him into a more open space, and had time to see that he was about 4 feet long.

At this juncture he nearly got away, for he traveled very fast downhill toward a belt of impenetrable scrub.

In trying to overtake and pass the snake with my eyes fixed on him, I ran blindly into a big bush of wait-a-bit thorn, which hooked into my bare arms as well as my clothes and so took me some seconds to free myself. I shouted to the boys to head him off, but Salimu, who like myself was very much out of practice, shielded his eyes with a slouch hat and would not go within 30 feet of its head; the other boys also were very tardy about coming forward. Salimu in passing him, however, caused him to halt in a bush and raise his head with spread hood. Just as he dropped to the ground I ran in and flicked him back 10 feet. He spat several times, but my eyes were shielded by my helmet. The cobra now tried to push his head under a fallen tree trunk and gave me the opportunity of running in and pinning his neck to the ground; the rest was plain sailing, though I had only a rather small bank cash bag to cram it into.

After my cautious handling of these snakes it was one of the most interesting and amusing incidents of the whole trip to watch Gurukesi and Kifinda remove these and four others from Shinyanga from their cage and pack them for shipment.

They were certainly very respectful toward the big one, but the others, which were about 4 feet long, Kifinda pulled out of their cage by their tails. Holding a cobra at arm's length in his left hand, with inflated cheeks he would make a dab with his right hand for the back of its neck; sometimes he missed and the twirling, wriggling reptile would nearly get him as it struck at his hand. Nevertheless, neither of them was bitten on this occasion. They both said, however, they had been bitten many times by black-necked cobras, which are common in their district and whose skins are in considerable demand for binding round the drums used in festivities.

When bitten they apply the "musaweye" medicine (as detailed under the notes on puff adders) but do not drink a decoction of it. They recover within 24 hours. I asked if they had ever known anyone to die from a bite of this snake; they replied in the affirmative, but said that if you applied the medicine and died it was not a real snake but a wizard ("mchawi"), in which case, of course, you could not expect the medicine to be efficacious.

They believe that it spits in your eyes to blind you, then bites your feet. If the venom gets in their eyes, they apply a "dawa" (katamakamakikulu) made of leaves of a small plant bearing the same

name and only a few inches in height. These leaves they chew, then rolling some other leaf to form a funnel, they discharge the spittle into the eyes of the person attacked, who is cured within the hour. I questioned this, and they said it was no infrequent occurrence for their dogs to put up a cobra and get spittle in the eyes; they claimed to be able to cure the animal immediately with "katamakamakikulu," so as to resume their walk without the eyes being inflamed or sight impaired.

To prevent a snake spitting they put a "dawa" called "ilende" into its mouth so that the poison will not fly but only dribbles from its jaws. Alternatively another plant called "ilumbalumba" is taken in the mouth of the snake "fundi" while he is bagging the snake and it causes the snake to miss its aim. This plant has a very pungent smell; they brought me one at my request, for it grows at Dodoma. I asked why they inflated their cheeks when handling the cobras and they said the snake was less likely to spit at you when you did so, as it thought you were going to spit at it! Nevertheless I saw the snakes did spit, though none of the venom got in the natives' eyes, as they were quick in turning their heads away.

DENDRASPIS ANGUSTICEPS (Smith)

GREEN OR BLACK MAMBA

Native names.—?Siana (Chigogo); Fune (Kiswahili).

It will be observed that the name given me by the Wagogo is the same as the Wanyimwezi name for the brown and olive boomslang; there may be some confusion. Near the river at Bahi Mr. Hockley was running after a wounded buck when a mamba shot across his path; five minutes later when quartering the cover he came up with and shot a snake which was apparently the same reptile. As I approached the bush in which it was it darted forward 3 feet (though shattered far back in the body near the tail) and struck at my stick most viciously. It measured over 7 feet but was far surpassed by a magnificent specimen, some 10 feet long, I should think, which was disturbed by Salimu as it basked among some rocks at the foot of one of the Dodoma kopjes. It passed within 20 feet of me as it crossed some open ground, and I had a good look at it. Both these snakes were dark olive in color though popularly known as black mambas. I saw two somewhat smaller ones at Saranda. The only live specimen obtained by the expedition was purchased by Mr. Carnochan near Shinyanga, but its fangs having been removed by its native captors it died within a month, as is usually the case with snakes so treated.

Gurukezi tells me that after a pupil of the Wayeye has gone through the preliminary exercises he is taken out into the bush by the old snake "fundis" to locate a mamba, which, when found, he is told to catch;

should he show fear, the snake doctors beat him with sticks until his fear of them is greater than that of the snake. Generally he gets bitten and is dreadfully ill, but recovers after treatment.

CAUSUS RHOMBEATUS (Lichtenstein)

COMMON NIGHT ADDER

Common night adders are splendid feeders in captivity; some specimens received from Tabora would take toads at noon almost from the hand. In one instance both captives seized one square-marked toad, the first by the left fore leg and the second by the right hind leg. I did not interfere (as the double dose of venom would make things quicker for the poor toad) until the first snake began to swallow from the head; then I attempted to push the second snake off with a flat foot ruler against its mouth. I succeeded eventually, but the bulldog tenacity displayed by the snake was astounding; it fought the ruler for its prey and if pried off at one point would seize at another. Instead of being discouraged by the turmoil the first snake only seemed eager to swallow faster; it actually took eight minutes from the time it struck until the toad's toes disappeared. The second snake lost no time in seizing another toad which it swallowed hind end first. Though doubtless narcotized to some extent the toad remained breathing and blinking its eyelids until its head was engulfed, actually closing its eye to avoid the ensheathed fang which pressed upon it. When swallowing began the fang appeared to be no longer used and remained folded back during deglutition.

CAUSUS RESIMUS (Peters)

GREEN NIGHT ADDER

Native name.—Fuko (Kinyamwezi).

I should think this species does not occur in the Dodoma district. Three specimens purchased in Shinyanga by Mr. Carnochan were all dead on arrival at Dodoma. In the initiation rite which he underwent he was subjected to the bite of this snake, which they correctly informed him was very poisonous; he was then "cured." He pointed out the individual snake to me on his return and on examining its mouth I found the poison fangs had been extirpated. Sc. 15, V. 152, A. 1, C. 16, L. 6.

BITIS ARIETANS (Merrem)

PUFF ADDER

Native name.—Kipili (Chigogo).

The native names for this common reptile are very confusing, as different names are applied to the same individual before and after casting or at different ages.

Some of them are as follows:

"Kipili." "Kiswahili" for young snakes, "Kinyamwezi" for young snakes, also very dark ones.

"Pilipili." "Kisagara" and "Kikami" for young snakes.

"Boma." "Kisagara" and "Kikami" for large snakes; "Kiswahili" and "Kinyamwezi" for yellow or desert-colored forms.

"Moma." "Kiswahili" for waterside puff adders (presumably dark-colored specimens in contradistinction to "Boma").

"Mamba ile." "Kinyamwezi" for large puff adders (reddish-brown specimens pointed out).

A very large series were gathered together from Dodoma, Saranda, Manyoni, Kondoa Irangi, and Shinyanga. The Dodoma snakes are very yellow in color, and I came across quite a number of them in the bush.

Gurukezi tells me that he was once bitten on the fore arm by a "moma"; he sucked the place and then rubbed on "dawa" without any ligaturing or incision. The medicine which he applied is known as "musaweye" and is composed of the leaves of "ilandoyakini," "kacooni," "mgwegwe," "mkuni," "munumbulu," "mtalali," "mkola," "musunga," "kalilalela," "musenga," and "mufuwati."

These are chewed up in the mouth and when dried have much the appearance of green cow dung. It is moistened and a few grains applied to the site of the bite, and a quantity about the size of an ordinary marble is mixed with water and drunk. If the mixture applied to the bite does not remain attached the medicine is no good for that species of snake, and another must be tried. The object of taking it by the mouth is to make the patient vomit the venom. Only one dose is taken.

The Wanyimwezi say that when the puff adder says "Ouuuu" it wants a bird called "kamunda" to eat. Then the "kamunda" comes near and is caught by the snake and swallowed; after feeding the snake retires to the grass in a gorged condition, remaining inert.

A native who was struck by one fang on the knuckle at the base of the index finger of his left hand showed no signs of poisoning on the first day (he was bitten at 9 o'clock in the morning) except that he was drowsy. The next day, however, his arm swelled gradually from the the hand to the shoulder until it was an enormous size by 4 o'clock in the afternoon and his condition was decidedly precarious. Within five minutes of being bitten he was in hospital and cautery and permanganate applied to rather superficial incisions at the site of the bite. Antivenene was injected on the second day.

It seemed possible that he might have recovered without any treatment; at any rate, on the fifth day he was able to rise and wash himself, and steadily improved.

They fed well on rats (*R. c. microdon and A. a. neumanni*).

A tick (*Rhipicephalus sanguineus*) was taken from a Shinyanga snake and another (*Amblyomma marmoreum*) from a Manyoni puff adder, taken on June 3, 1926.

LACERTILIA

HEMIDACTYLUS SQUAMULATUS Tornier

A single specimen taken at 8 o'clock in the evening in Dodoma township as it was running across the road. An interesting pallid variety in conformity with such a sandy habitat, the chainlike dorsal markings are only faintly discernible. It has 7 upper and 6 lower labials on the right, 8 upper and 6 lower on the left side.

HEMIDACTYLUS MABOUIA (Moreau de Jonnès)

HOUSE GECKO

Native name.—Ikaka (Chigogo).

Dodoma, Nzingi, Saranda, Manyoni, in houses or on rocky kopjes. At Nzingi two pairs of eggs were found adhering to the under surface of a rock; in one pair were advanced embryos (25. v. 26). These geckos were eaten by captive specimens of the spotted wood snake (*Philothamnus semivariegatus*).

LYGODACTYLUS GROTEI Sternfeld

Dodoma, Bahi, Saranda, Manyoni, Mukwese, on doorposts, fences, and tree trunks. This gecko replaces *L. p. picturatus* in the Dodoma district but was nowhere very common, unless an exception is made of the fence posts at Manyoni station. At Saranda only four were seen in 10 days.

The upper labials in this series range from 6 to 9, the lower labials from 5 to 9; one Dodoma gecko has 7 praeanal pores, the maximum hitherto being 6.

PACHYDACTYLUS BIBRONII (Smith)

A female from Dodoma taken on a wall of a room where *H. mabouia* was common. (19. vi. 26.).

On the left side of the head in this specimen the nostril is pierced between one large anterior and two small posterior nasals; on the right side it is between a large anterior and three small posterior scales. It is the largest example I have ever taken, measuring 6¼ inches (81 + 75 mm.) from rostral to tip of tail. In its stomach were seven large earwigs. A spotted wood snake (*Philothamnus semivariegatus*) was captured at Manyoni in the act of swallowing one of these geckos.

PACHYDACTYLUS TRIEDRUS (Boulenger)

A male, taken on the wall of an outbuilding at Saranda, the same wall being frequented by *H. mabouia* (7. vii. 26).

It has the nostril pierced between the rostral, first labial, and four small scales on the right side of the head; on the left side the labial,

is excluded from the nostril. It appears to be the largest example of its species recorded, as it measures $6\frac{5}{8}$ inches (79 + 88 mm.). There were many termites in its stomach.

AGAMA HISPIDA DISTANTI Boulenger

DISTANT'S AGAMA

Native name.—Ikulumbi (Chigogo).

Very common at Dodoma on paths in the township. It has a habit of basking on the rails of the main line to Nzingi, and would remain until the trolley, which was traveling at 10 miles an hour, was within 2 feet. A great many were disturbed in this way, but none killed. Two juveniles were taken at Mukwese on June 6, 1926.

AGAMA LIONOTUS DODOMAE Loveridge

DODOMA AGAMA

Native name.—Ntunu (Chigogo).

Dodoma, Nzingi, Saranda, Manyoni, Mukwese.

The young are more or less abundant; the adults extremely scarce. In captivity they were observed to eat grasshoppers, flies, and termites sparingly; they did not thrive, however.

AGAMA LIONOTUS MWANZAE Loveridge

MWANZA AGAMA

Mr. Carnochan has increased our knowledge of the distribution of this handsome lizard by collecting a series from Kizumbi in the Shinyanga subdistrict. Unfortunately, they were very emaciated on arrival at Dodoma and did not feed well, though both insects and vegetable food were proffered. Doctor Thompson, long resident in Mwanza, tells me that this lizard is quite a pest in the gardens there, biting through flower stems so frequently that it was difficult to rear plants at all.

Another interesting fact which he told me and which has since been confirmed by another Mwanza resident is that this race quite frequently enters houses, a thing its Dodoma relative never seems to do.

VARANUS OCELLATUS Rüppell

EYE-SPOTTED MONITOR

One received from Tabora district.

VARANUS NILOTICUS (Linnaeus)

NILOTIC MONITOR

Native name.—Libulu (Chigogo).

Four from Shinyanga subdistrict.

A monitor is said to occur along the river, which is 5 miles north of Saranda station.

NUCRAS EMINI Boulenger

One from Mukwese, near Manyoni, quite typical, with 45 scales across mid-body and 32 transverse rows of ventrals.

LATASTIA JOHNSTONI Boulenger

JOHNSTON'S LIZARD

Two specimens collected at Saranda had been eating (1) termites, (2) a grasshopper.

LATASTIA LONGICAUDATA REVOILI (Vaillant).

EAST AFRICAN LONG-TAILED LIZARD

Dodoma, Nzingi, Bahi. Very common along the railway line and in the cultivated plots of the natives. When disturbed these lizards usually dash down very superficial holes near the base of a bush. If the fallen leaves are cleared away from the vicinity, it will invariably be found that not far off there is a second opening to the burrow. From this the lizard will attempt its escape if digging operations are begun at the hole where it went in. By stopping up the second hole and digging carefully it is not difficult to capture these fleet lizards. One male had the longest tail of any I have caught, its length from snout to vent was only 3¼ inches (84+230 mm.).

Stomach contents were (1) a full-grown *Eremias spekii*, (2) scorpion, (3) termites, (4) termites, a different species, (5) termites and earwigs.

As already related, one was recovered from the stomach of a snake (*Psammophis biseriatus*).

EREMIAS SPEKII SPEKII Günther

SPEKE'S LIZARD

Common at Dodoma, Nzingi, and Saranda.

As already mentioned, one was found in the stomach of a lizard (*Latastia longicaudata revoili*).

GERRHOSAURUS FLAVIGULARIS FLAVIGULARIS Wiegmann

YELLOW-THROATED LIZARD

Native names.—Sampula mhange or sangarazi (Kikami). The first name refers to an alleged habit of this lizard, which is said to strip bean grass (*majani mbazi*) from its stalk and carry it to its hole. The second name, sangaraza, is applied to the snake (*Psammophis sub-*

taeniatus) but is quite correctly employed for the lizard, said Salimu. They call *Gerrhosaurus major* by a different name—namely, "guguru."

Seen at Saranda and Mukwese, but none were collected.

MABUYA PLANIFRONS (Peters)

A skink, which I believe to belong to this species, was seen on tree trunks in the maiombo bush at Saranda on several occasions. They were by no means common and, as they retreated into holes in the tree trunks, I was unable to obtain any.

MABUYA QUINQUETAENIATA (Lichtenstein)

FIVE-LINED SKINK

MABUYA VARIA VARIA (Peters)

VARIEGATED SKINK

MABUYA STRIATA (Peters)

STRIPED SKINK

All three species occur at Dodoma, the two former on the rocky kopjes, the latter ubiquitous but chiefly seen about huts and houses. Besides Dodoma, both the latter were seen at Nzingi, Bahi, Saranda, Manyoni, and Mukwese. At Nzingi, hearing a noise among some bowlders, I approached quietly to find a variegated skink hammering a large grasshopper on the ground.

LYGOSOMA FERRANDII Boulenger

FERRANDI'S SKINK

Two from Dodoma and one (alive) from Mukwese, all taken beneath logs.

The anterior nasal is fused with the supranasal, with the result that the nostril is between two instead of three shields. In the skink taken in June the frontal is in contact with the first supraocular on the left side only; in the male taken June 30 it is in contact with the first three supraoculars on the right side only, where there are five supraoculars. The fourth upper labial is longest and the fifth deepest. No dorsal spots or lateral lines. The total length of the male is 130 (71 + 59) mm.

CHAMAELEO DILEPIS DILEPIS Leach

COMMON EAST AFRICAN CHAMELEON

Native names.—Luivu (Chigogo); Ngasi (Wambu); Ngasi (Wakimbu); Kinyonga (Kiswahili).

From Dodoma, Manyoni, Mukwese, and Kondoa Irangi.

About 70 chameleons in all were received. One would scarcely expect such reptiles to be common at Dodoma, and yet nearly 40 were brought in during the first six weeks.

If the subspecies *isabellinus* Günther is recognizable, then all these examples should be referred to that form on the strength of the large, flat scutes on the occipital lobes which differ so strikingly from those of typical West African *dilepis;* the commissure of the mouth is proportionately longer, but there is no appreciable difference in the scutes on the crown, being "flat, not tubercular."

They were fed upon small grasshoppers, which they ate with avidity; apparently flies were only taken when the reptiles were hungry. I had no idea that chameleons would drink, but on my return from Manyoni I placed bowls of water in their cages and saw many chameleons descend to the edge of the bowl and drink as deeply as a tortoise would. Worms (*Strongylurus brevicauda*) were recovered from the stomach of one that died.

AMPHIBIA

XENOPUS MÜLLERI Peters

MÜLLER'S SMOOTH-CLAWED FROG

Common in the deeper wells and water holes near Dodoma township and in marshy spots at Ikikuyu, a few miles from the town. As the water in the wells was 15 feet below the level of the ground, apparently it is impossible for these frogs to escape except perhaps during the rainy season.

The tentacle of an adult taken on May 14, 1926, measures three-quarters the diameter of the eye, but in two young ones collected on August 19, 1926, the tentacles are barely distinguishable and without the adult I should have referred them to *X. laevis.* When the fingers of the right hand are laid together their relative length from the longest to the shortest are 2d, 3d = 1st, 4th; on the left hand 2d, 3d, 1st, 4th.

Two score small frogs taken from Ikikuyu were safely landed in the United States, where they have been doing well for the last six months.

RANA MASCARENIENSIS Duméril and Bibron

MASCARENE FROG

Twenty-eight specimens collected at Dodoma, Bahi, and Mukwese. One was taken in an empty packing case in a back yard of a vacant house at Dodoma, a long way from the nearest water.

On the outward voyage when we put into Kilindini Harbor, Kenya Colony, on May 3, 1926, Mascarene frogs were seen and heard calling. At Dodoma a great many were eaten by the sharp-nosed snakes (*Rhamphiophis oxyrhynchus*).

RANA DELALANDII (Duméril and Bibron)

A single example from a swampy water hole at Mukwese on June 6, 1926.

PHRYNOBATRACHUS NATALENSIS (Smith)

Fifteen specimens from a swampy water hole at Mukwese on June 6, 1926.

CHIROMANTIS PETERSII Boulenger

Six examples were found squatting on aloes, manyara, maize leaves, a post, and in an empty box at Dodoma. Another was taken at Mukwese. As they were found during the dry months, from May to August, apparently they do not aestivate or disappear as *C. xerampelina* appears to do.

The length of the frogs in this series ranges from 30 to 65 mm.

I should be inclined to call the loreal region "more or less concave" in all these specimens; in the largest it takes the form of a groove. In most of them the interorbital space equals the width of the upper eyelid, but in one it is less than the width of the upper eyelid. Without actual comparison with the type of *C. kachowskii* Nikolsky from Abyssinia it is impossible to say how far they overlap. In the largest specimen the snout is longer than the greatest orbital diameter; the nostril is a little nearer the end of the snout than it is to the eye. The tibio-tarsal articulation of the adpressed hind limb hardly reaches the ear in the biggest frog, obviously a matter of growth, as in the smallest examples it reaches well forward on the eye and in individuals intermediate in size it falls between the two extremes.

EXPLANATION OF PLATES

Plate 1

Photographs by R. H. Rockwell

Upper: Typical Wagogo kraal in Dodoma district.
Middle: Wagogo cattle sheltering under Mimosa trees.
Lower: Indian shops in Dodoma township.

Plate 2

Upper: Combined leopard trap and cage.
Two leopards and one civet were taken at this spot. The bait, consisting of a live goat, is protected by a dense mass of thorns.
Middle: Building a stockade for a giraffe drive at Tulo.
Lower: A corner of the bird room at Dodoma.

Plate 3

Upper: Nest and eggs of finch lark (*Eremopteryx leucopareia*).
The nest is a mere depression lined with fibers and rootlets, having scarcely any bottom to it.
Middle: Catching a spitting cobra.
By rapidly circling round the reptile it is wearied and eventually drops to the ground for a second. This gives one the opportunity of running in and pinning it to the ground with a forked stick. As the venom carries 6 feet it is necessary to shield the eyes; a cloth is often useful at the moment of capture to distract the reptile's attention.
Lower: Termite workings where a tree frog (*Chiromantis petersii*) was found regaling himself at a break in the galleries.

Plate 4

Photographs by William M. Mann

Upper: Zanzibar galago (*Galago garnettii*), the first animal obtained by the expedition. Photograph taken after a year in captivity.
Middle: White-bearded gnu (*Connochastes taurinus hecki*) after six months in Washington.
Lower: Soft-shelled tortoise (*Testudo tornieri*) from Dodoma.

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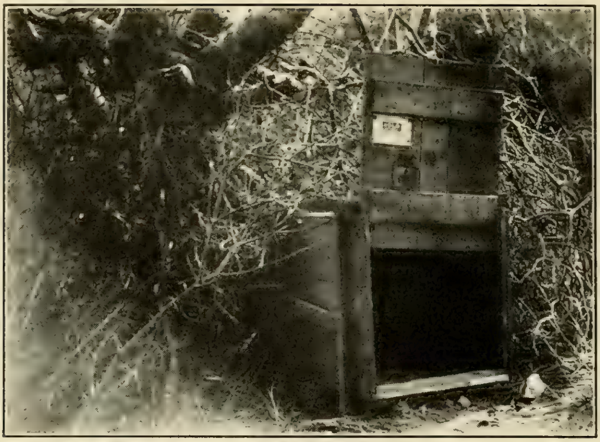
TYPICAL WAGOGO KRAAL IN DODOMA DISTRICT

WAGOGO CATTLE SHELTERING UNDER MIMOSA TREES

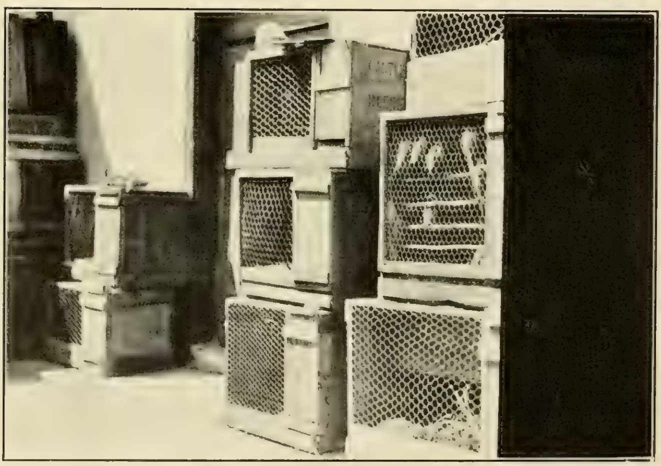
INDIAN SHOPS IN DODOMA TOWNSHIP

FOR EXPLANATION OF PLATE SEE PAGE 69



Combined Leopard Trap and Cage

Building Stockade at Tulo



A Corner of the Bird Room

For explanation of plate see page 69

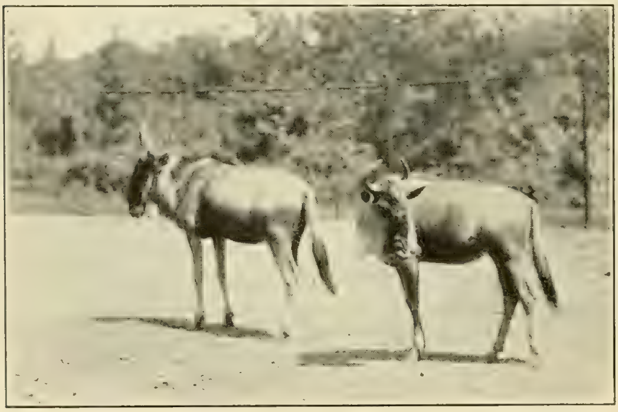
Nest and Eggs of Finch Lark

Catching a Spitting Cobra

Termite Workings Where a Tree Frog was Found

For explanation of plate see page 69

Zanzibar Galago, the First Animal Obtained by Expedition



White-bearded Gnu after Six Months in Washington

Soft-shelled Tortoise from Dodoma

For explanation of plate see page 69

TWO NEW SPECIES OF COMMENSAL COPEPODS FROM THE WOODS HOLE REGION

By H. R. Seiwell
Of the University of North Carolina

During the summer of 1925 I discovered that the common sea pork, *Amaroucium*, collected in the vicinity of Woods Hole, Mass., contained Harpactid copepods in its branchial chamber.

A dozen pieces of *Amaroucium*, 4 to 5 inches in length, were collected, and after being washed in fresh water and carefully wiped were placed in a dish of strained sea water and cut in pieces. The sea water was strained three times through No. 18 Müller bolting silk. The mesh of this bolting silk is sufficient to remove any copepods which might be present. At the end of a few minutes the contained copepods were carefully picked out of the dish with a small pipette and killed in formalin. An examination revealed two species of Harpactids, both of which were new to science and are described in this paper. Both were in sufficient abundance to well establish the species. Twelve specimens of *Tisbe wilsoni*, including a single male, and 14 specimens of *Amphiascus commensalis*, including three males, were collected.

I wish to express my appreciation to Dr. C. B. Wilson for the helpful assistance he gave me in the identification of these forms.

Genus AMPHIASCUS G. O. Sars, 1905

Generic characters.—Body slender, cylindrical in form with the anterior and posterior divisions not sharply marked from each other. Cephalic segment of moderate size and not deep, rostrum well defined and very mobile. Urosome with the genital segment in female imperfectly divided in the center, and scarcely dilated in front; posterior edge of all the caudal segments finely spinulose on the ventral and lateral faces. Caudal rami generally short; apical setae slender. Anterior antennae of usual structure, and, as a rule, composed of eight articulations, four of which belong to the terminal part. Posterior antennae with the terminal joint dilated distally and armed outside with strong spines, at the tip with slender geniculate setae;

outer ramus very narrow, generally three articulations, middle joint quite short and, in some instances, imperfectly defined. Oral parts normal. First pair of legs with both rami triarticulate, the outer one much shorter than the inner, and in some cases resembling, in structure, that of the genus *Dactylopusia;* inner ramus with the first joint slender and elongated, setae of inner edge attached close to the end. Inner ramus of second pair of legs in male conspicuously transformed, outer two joints confluent. Last pair of legs foliaceous, with the proximal joint expanded inside; those in the male much smaller than in the female.

AMPHIASCUS COMMENSALIS, new species

Specific characters—Adult male (Holotype, Cat. No. 61141, U.S.N.M.)—Body proportion about the same as the female; male shorter than the female. First antenna slightly longer than that of female, first joint as long as fourth, second longer than third but shorter than first, terminal portion a little more than one-half the length of the posterior portion. Inner ramus of second pair of legs transformed in the usual manner. Inner ramus of second pair longer than the outer, distal joint produced at the end to a strong mucroniform projection. Last pair of legs much smaller than in the female, with only two setae on the inner expansion of the proximal joint. Distal joint oval, nearly circular in form, provided with five setae of irregular length. The body has a yellowish color.

Adult female.—Body moderately slender, with the posterior divisions slightly narrower than anterior. Cephalic segment practically as long as the four succeeding segments combined. Epimeral parts evenly rounded in front. Rostrum prominent and lanceolate. Urosome about the length of the anterior division and tapering slightly behind. Last segment corresponding approximately in length to the preceding one. Furcal rami shorter than the anal segment, outer and inner apical setae short. Anterior antennae comparatively short and tapered distally, first joint much the longest, third joint slightly longer than the second, and fourth longer than the third, terminal portion about one-half the length of the posterior portion. First pair of legs rather slender, outer ramus as long as the first joint of the inner, all three joints of outer ramus approximately equal in length, terminal joint with two clawlike spines and joints about one-half as long as proximal joint. Last pair of legs with the distal joint not long, oval in form, carrying five unequal setae, inner expansion of proximal joint comparatively short, marginal setae, five, the the middle one being the longest. Ovisac extending slightly beyond the center of the urosome.

Total length of female, 0.74 millimeter. Length of anterior body, 0.38 millimeter. Mean width of anterior portion, 0.18 millimeter.

Genus TISBE Lilljeborg 1853 (IDYA, Philippi, 1843, preoccupied)

Generic characters.—Body distinctly depressed, with the anterior and posterior divisions sharply defined. Cephalic segment of moderate size, narrowly produced in front, rostral projection short and obtuse, not defined at the base. Epimeral plates of the three succeeding segments, rather broad, lamellar, obtuse at the tips. Last segment of metasome very small. Urosome moderately slender, with the genital segment in female distinctly divided in the center. Genital tubercles in male each armed with a strong, posteriorly pointing spine. Caudal rami generally short but with some of the apical setae much elongated. Eye normal. Anterior antennae slender and attenuated, eight articulate, sensory filaments of fourth joint fully developed; those of male slightly transformed, subprehensile. Posterior antennae with the outer ramus well developed, four articulate. Anterior lip prominent, tapering distally, terminal edge minutely denticulate. Mandibles with the masticatory part rather slender and coarsely dentated at the tip, palp of comparatively simple structure, though distinctly biramous. Maxillae with the palp slightly lobular, epipodal lobe wholly absent. Both pairs of maxillipeds uncinate at the tip, the anterior ones biarticulate, with a single slender lateral lobe at the junction of the two joints, the posterior ones distinctly three articulate, with a single apical claw. First pair of legs with both rami three articulate, but rather unequal in size and structure, the inner one much larger than the outer and having the penultimate joint prolonged, the last very small with two comparatively short claws, outer ramus with the spine of the first joint, as a rule, elongated, that of the second joint issuing from near the end, last joint provided at the inner corner with two slender ciliated setae, and along the obliquely truncated end with four outward curving spines gradually increasing in length, and each like that of the second joint, penicillate at the tip, or clothed on one edge with a limited number of long cilia. Natatory legs comparatively well developed, with the rami nearly equal and the joints broad sublamellar, middle joint of inner ramus in all pairs with two natatory setae. Last pair of legs slender, extended laterally, proximal joint very slightly expanded inside, distal joint generally narrow, linear, those in male similar though somewhat smaller than in female.

TISBE WILSONI, new species

Specific characters—Adult male (Holotype, Cat. No. 61142, U.S.N.M.).—Body of male grayish white with a dark patch in the epimeral plate on either side of the first four thoracic segments. The first segment being fused with the head, its two patches appear near the posterior margin of the cephalothorax. Eye visible. Body much more slender and elongated than that of female, anterior and pos-

terior portions in the ratio of 5 to 4, genital segment distinctly divided in front of the center, both portions the same width, abdomen with four segments between the genital segment and furca. Segments diminishing considerably in length backward, but only slightly in width. Furca about the same length as the anal segment and like that of the female. First antennae symmetrical, geniculate, terminal portion consisting of the last two joints. Aesthetasc relatively larger than in the female. Appendages corresponding to those of the female.

Total length, 0.70 millimeter. Greatest width, 0.22 millimeter.

Adult female.—Body of female creamy white and fairly transparent. The ovaries and convoluted oviduct of a dark brown color and showing distinctly through the dorsal integument. Body moderately slender, the anterior division quite regularly oval in outline and about twice as long as wide, evenly rounded anteriorly and posteriorly, posterior division considerably less than half the anterior in both length and width. Genital segment distinctly divided at the center, the anterior half swollen laterally, the posterior half with straight lateral margins. Furcal rami longer than the anal segment, outer and inner apical setae short and bent at the base. Anterior antennae long and tapered distally, the second joint longer than the third, the fourth a trifle shorter than the third, terminal portion about twice the length of the fourth joint. Mandible with three proximal teeth increasing in size distally, and a row of five small distal teeth all about the same size; palp distinctly biramose, each ramus tipped with long and stout setae. First maxillae with no epipodal lobe and the palp not lobular, both maxillae and the palp tipped with a tuft of setae. Second maxillae with a curved terminal claw longer than the swollen basal joint and a long slender seta at the base, claw on the inner side. Maxilliped not as stout as second maxilla, its second joint armed with a short spine at the center of the outer margin, and a row of stiff bristles along the inner margin, terminal claw shorter than the second joint and slightly curved with a slender seta inside at its base. First legs with the endopod rather slender and nearly twice the length of the exopod, the second joint slightly longer than the basal one, the terminal joint nearly spherical and tipped with two small claws without plumes, claws on the second and third joints of the exopods showing distinctly at their tips, as well as the tufts of plumes characteristic of this genus. Fifth legs with a short basal joint not much widened, its inner expansion tipped with a long seta and two very short ones, terminal joint broad and lamellate, its width two-fifths of its length, with a very stout spine just beyond the center of the outer margin, three terminal setae, the central one the longest, and a minute spine on the outer margin near the tip.

Total length, 0.94 millimeter. Length of anterior body, 0.60 millimeter. Greatest width (cephalon), 0.35 millimeter. Length of posterior body, 0.34 millimeter. Width (genital segment), 0.15 millimeter.

EXPLANATION OF PLATES

PLATE 1

Amphiascus commensalis, new species

FIG. 1. Female, fourth leg.
2. Male, holotype, fourth leg.
3. Same, first leg.
4. Same, second leg.
5. Same, fifth leg.
6. Female, holotype.
7. Same, second leg.
8. Same, fifth leg.
9. Male, holotype, first antenna.
10. Female, mandible.
11. Same, rostrum.
12. Male, holotype, second leg.
13. Female, holotype, second antenna.
14. Same, first antenna.

PLATE 2

Tisbe wilsoni, new species

FIG. 1. Female.
2. Mandible.
3. Female, second leg.
4. Male, holotype.
5. Same, fourth leg.
6. Same, second antenna.
7. Same, first maxilla.
8. Male, holotype, first antenna.
9. Same, second maxilla.
10. Female, fifth leg.
11. Male, holotype, first leg.
12. Same, first maxilliped.
13. Male, holotype, fifth leg.

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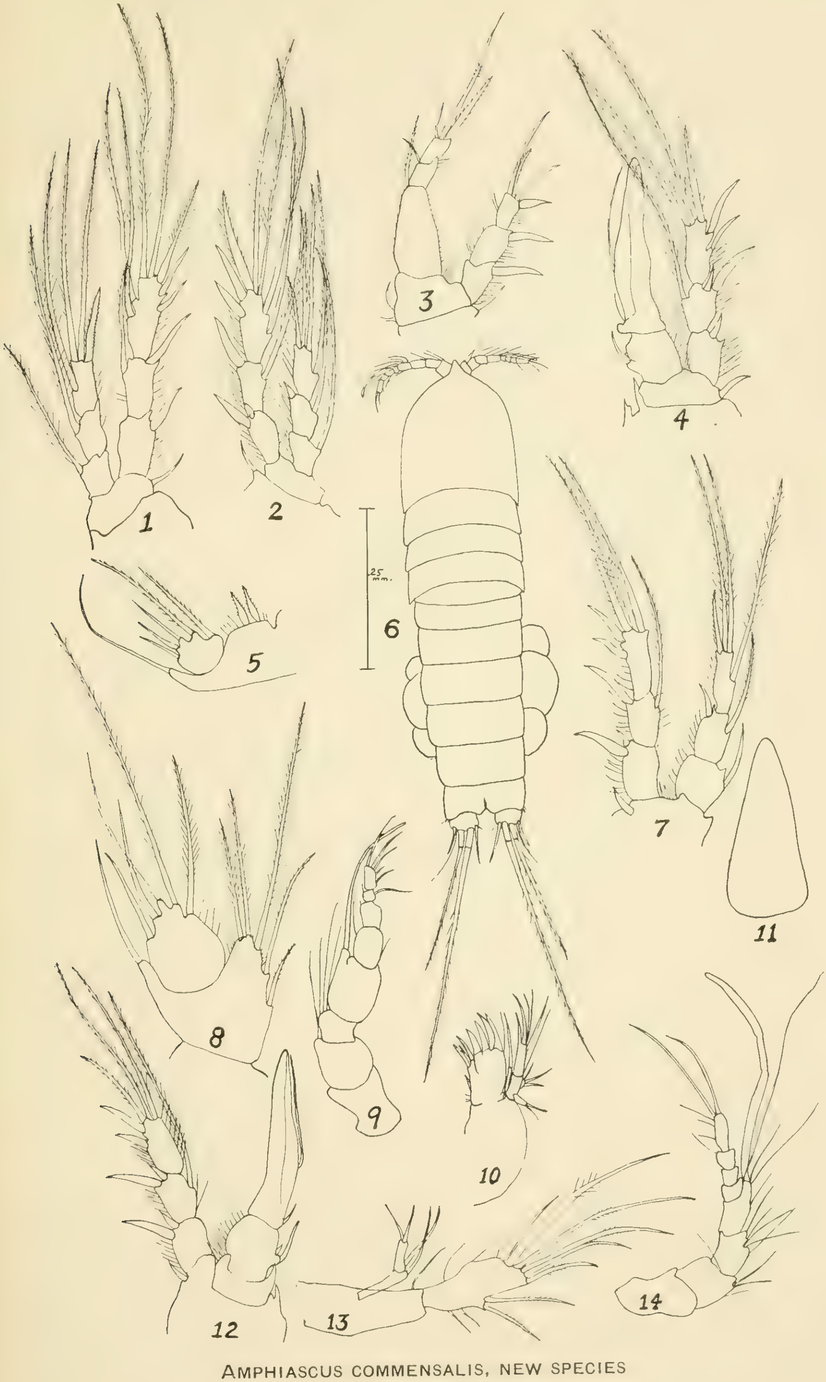
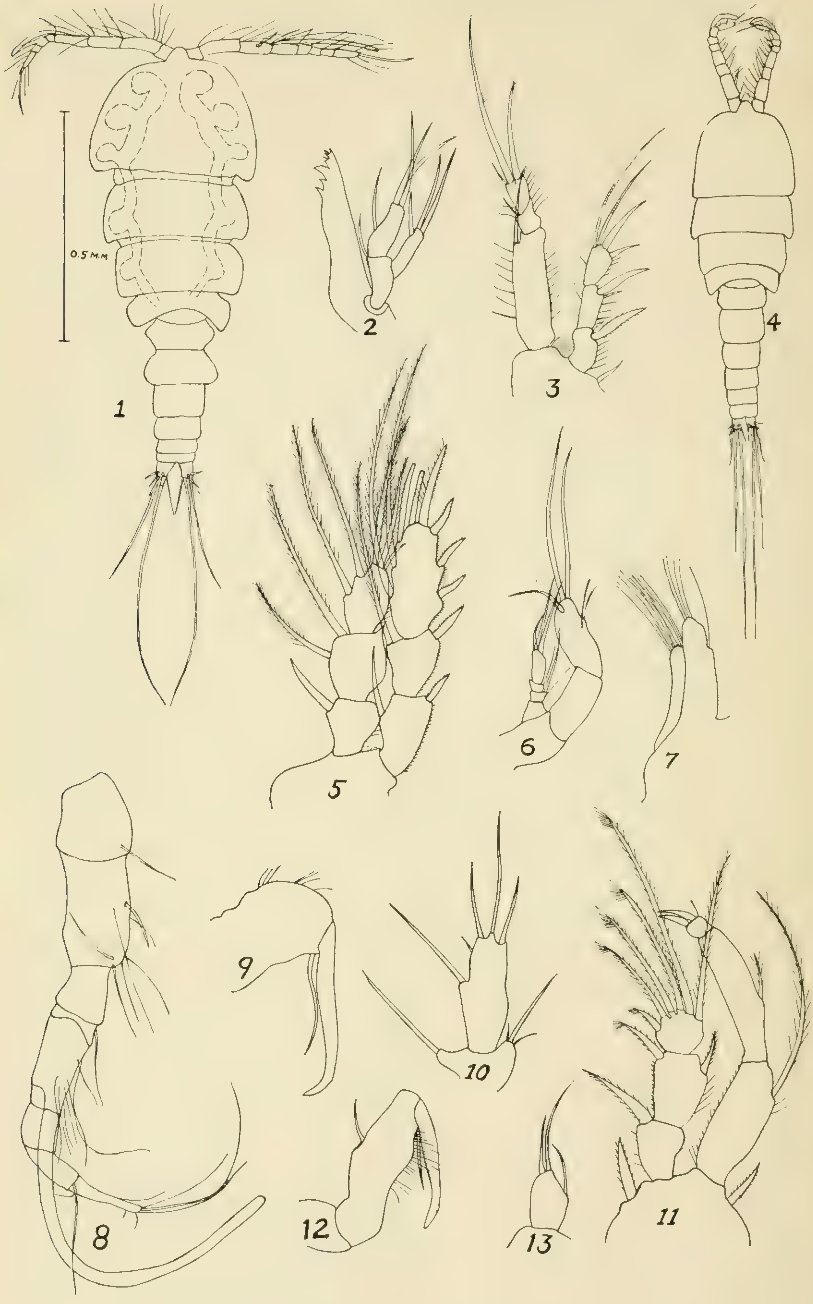


AMPHIASCUS COMMENSALIS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 5



TISBE WILSONI, NEW SPECIES

For explanation of plate see page 5

NEW MOTHS OF THE FAMILY CERURIDAE (NOTODONTIDAE) IN THE UNITED STATES NATIONAL MUSEUM

By WILLIAM SCHAUS,

Honorary Assistant Curator, United States National Museum

One hundred and sixty species are described under the above heading, and of these 127 are Neotropical, consisting of 50 species from the Dognin collection, 24 paratypes presented by the Carnegie Museum of Pittsburgh, and the balance chiefly presented to the Museum by myself.

There are 33 species described from the Orient; 8 of these were collected by the Rev. D. C. Graham in China, 3 from India, 3 collected in Java by Messrs. Bryant and May, and 19 received from the late Charles Fuller Baker.

SPECIES FROM CENTRAL AND SOUTH AMERICA

NYSTALEA BIUMBRATA, new species

Male.—Palpi gray streaked above with burnt umber, finely edged with black. Head and front of collar fuscous or buffish. Thorax pale smoke gray. Abdomen above mouse gray, underneath whitish mottled with light brown; a lateral white spot at base. Fore wing silvery gray with darker suffusions on antemedial and terminal areas; some fine black striae on base, and a fine, double, irregular antemedial black line; antemedial area outwardly edged by an irregular double fawn color line, projecting on costa and across median, where it is preceded by a small black spot; discocellular line incurved, whitish with some black scales, followed by a fine lunular dark line; postmedial line double, fuscous, outcurved, lunular from vein 3 to inner margin, and containing some small black lunules; a burnt umber lunular line beyond, the veins before it with black and white points; subterminal deep black spots on either side of veins; marginal fuscous black spots on interspaces; a broken terminal black line; cilia benzo brown with pale spots at veins. Hind wing white; veins, costa, and termen narrowly fuscous, the terminal shade narrowing to anal angle; cilia white.

Expanse 50 mm.

Habitat.—Tucuman, Argentina.

Type.—Cat. No. 33292, U.S.N.M.

Nearest *N. plumipes* Schaus in markings.

In a series of specimens there is variability in the intensity of the markings.

NYSTALEA EASTMANI, new species

Male.—Palpi, with second joint well fringed in front, snuff brown mottled with white hairs. Frons snuff brown with converging buff hairs. Vertex and collar snuff brown. Thorax mostly gray, the tegulae crossed by two faint dark lines. Abdomen above grayish with transverse hair brown lines and light buff tufts at base; underneath buff white. Fore and mid legs chiefly chestnut brown with light buff transverse lines; hind tibiae clothed with long light buff hairs, the hind tarsi mostly fuscous with white rings. Fore wing: Base from costa to vein 1 expanding below cell, grayish white, crossed by some short black lines limited by the fine and partly double irregular antemedial line; medial space fawn color, widest at costa and cell, limited by a double dark line outbent from costa, angled at vein 3, lunular from cell to inner margin; a series of seven black points along middle of cell; postmedial space white, irrorated with some dark scaling and crossed beyond discocellular by a faint outcurved dark line; discocellular white in front; an outbent army brown and black line from vein 5 to vein 4; the postmedial space limited by a double dark lunular line, inbent below vein 2, mostly followed by a cinnamon shade and some verona brown spots; terminal space mostly fawn color; an irregular series of sepia lunules partly preceded by some drab gray shading; whitish irrorations on termen; a broken terminal benzo brown line; cilia white with brown patches on interspaces. Hind wing white largely suffused with drab, the veins and termen broadly hair brown.

Expanse 49 mm.

Habitat.—British Guiana(?)

Type.—Cat. No. 33293, U.S.N.M.

Somewhat like *N. indiana* Grote.

Named in honor of Mr. G. Eastman, a generous contributor to the Dognin fund.

NYSTALEA JULITHA, new species.

Male.—Palpi wood brown. Head, collar, and front of thorax fuscous, thorax otherwise and shoulders pale drab gray. Abdomen above drab, underneath buffish. Fore wing pale wood brown; double fuscous antemedial, medial and postmedial lines on costa; a fine dark streak through cell and on veins from cell; a deeply outangled double line medially, above and below submedian vein; a faint dark line on discocellular; traces of an outcurved postmedial line, better marked

toward inner margin; a wavy fuscous subterminal line from vein 3 to tornus. Hind wing drab, darkest on termen; a slight whitish shade at base.

Expanse 60 mm.

Habitat.—Paneiras, Rio, Brazil.

Type.—Cat. No. 33294, U.S.N.M.

NYSTALEA PARSONI, new species

Female.—Palpi: Second joint with hazel stripe above; a light drab streak laterally. Frons white; hazel tufts at base of antenna; tuft on vertex and front of collar light buff, collar otherwise ochraceous tawny. Thorax benzo brown. Abdomen above hair brown with pale hairs at base and a raised dorsal hazel tuft; underneath abdomen light buff, the thorax cinnamon drab. Fore wing largely hair brown with dull purplish suffusions, the inner margin and termen broadly tawny olive except between veins 4 and 6; the lines mostly fuscous; a black and white streak on median near base; antemedial line double, outangled on costa, filled in with buff, less angled below cell; medial line double, irregular, lunular, and inbent below cell, on costa filled in with hazel; reniform long and narrow, buffish broken by dark lines, followed by an outcurved black line from costa to submedian fold where it is marked by a small brownish olive or fuscous spot; postmedial line double, lunular, filled in with brownish, almost vertical, outwardly edged partly with some white scales; a sinuous hazel line follows; a subterminal line from below costa consisting of chestnut brown lunules followed by some white scales, above and below vein 2 suffusing with dark terminal spots; cilia mottled fuscous and wood brown. Hind wing hair brown; base, inner margin, and cilia at tornus light buff; cilia avellaneous toward apex.

Expanse 65 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33295, U.S.N.M.

Described from three females in the United States National Museum.

Allied to *N. porgana* Schaus, but smaller, more variegated, the apical pale area of fore wing more elongated and not so broad.

NYSTALEA AMATURA, new species

Male.—Closely allied to *N. mocotana* Schaus which is the male of *N. marmorea* Schaus, the latter name having priority. Fore wing darker and more evenly benzo brown, the apical pale spot shorter, edged behind by a white line from costa, but not reaching termen; reniform vertical, defined by darker lines and without any white. Hind wing white, somewhat suffused with brown; termen broadly hair brown; veins hair brown.

Expanse 52 mm.

Habitat.—British Guiana; Amatura, Amazons.

Type.—Cat. No. 33296, U.S.N.M.

ELYMIOTIS CORANA, new species

Male.—Palpi almost entirely dark purplish on first two joints, the end of second joint, tips of fringe and third joint dull brown. Frons dull brown or buffish with a black spot and diverging black lines. Collar and thorax sayal brown, with a black transverse line on metathorax, the tegulae mostly white with a few black scales and clay color scales on dorsal edge. Abdomen above drab with black segmental line and spot at end of body, also black tips to anal hairs; underneath whitish with three black lines more or less interrupted. Fore wing silvery drab gray, the lines fuscous; a black mark at base of costa; subbasal line double to fold, lunular; antemedial line double, oblique on costa, inbent along subcostal, outbent and angled on median, with dark lines below it in cell, below median inset with raised velvety fuscous black scales vertically to vein 1; a small velvety spot at lower angle of cell, and one above it slightly outset; a dark shade above median and vein 4 to outer line with a fine, interrupted line above it; a whitish shade from base of veins 4 to 2 to outer line; outer line black on costa, sinuous, outbent, then outcurved, lunular and inbent to near middle of inner margin, a triangular white mark on it between veins 5 and 4; the terminal area suffused with drab between veins 4 and 6; veins 5 and 6 broadly black, and velvety fuscous black streaks above veins 4, 5, and 6; a fine submarginal crenulate black line; a terminal dark line; cilia wood brown with fuscous spots at veins. Hind wing benzo brown, with traces of white in cell, and sometimes along inner margin, below and beyond cell; cilia white; the usual double spot at anal angle.

The female is more uniformly drab gray, the lines less prominent, the spots on discocellular smaller. Both sexes have the hind wing below white, the termen broadly hair brown, narrower, and interrupted at anal angle.

Expanse, male, 48 mm.; female, 54 mm.

Habitat.—Mexico to French Guiana.

Type.—Cat. No. 33297, U.S.N.M.

This species has been called *longara* Stoll, *attenuata* Walker, and *ancora* Feld. According to Stoll's figure and description of *longara* the antennae are pectinated; *attenuata* Walker is a smaller species from Venezuela of which we have a male and three females; *ancora* Fielder is also small and represents a species allied to *E. complicata* Dognin. In the Transactions of the Entomological Society of London (1901, p. 272), I placed *purpurascens* Butler as a synonym of *attenuata;* described from a female, it belongs to a distinct species.

ELYMIOTIS MORANA, new species

Male.—Palpi dusky drab with a few whitish hairs; a steel black line at upper edge, and fuscous transverse line at end of second joint. Head, collar, and thorax chestnut brown mottled with dusky drab; tegulae brownish drab. Abdomen above deep brownish drab with dorsal and lateral whitish buff hairs at base, and a dusky brown dorsal tuft on second segment; a fuscous segmental line towards end of abdomen; underneath buffish with an interrupted fuscous ventral line and outer fuscous lines on last three segments. Fore wing brownish drab, the base and veins to middle of wing irrorated with sea-foam green and black scales; a velvety black broken subbasal line; antemedial line double, velvety black, lunular, inset at fold, so the outer line falls below the inner line; a double dark medial line, outbent to within cell where it is marked by fine velvety lines, inset below median, where the inner line consists of raised velvety black scales reaching vein 1 and is preceded by a triangular fuscous shade; a round velvety black spot at lower angle of cell, a small spot edged with white above it basad, and a vertical streak above it outset; a velvety fuscous line in cell from medial line, extending well beyond it, below vein 5 marked beyond cell by a short silvery white line, interrupted and continued with a branching curved tip; some pale sea-foam green scaling at base of interspaces between veins 2 and 4; postmedial line double, wavily lunular, sorghum brown filled in with avellaneous, well outcurved beyond cell with a white line inwardly on inner margin; subterminal velvety short fuscous streaks above veins 5 and 6; a marginal fine, crenulate, black line; cilia mottled fuscous and avellaneous with white points at veins. Hind wing benzo brown, the cell white; base below cell white extending toward termen, some dark scaling before anal angle crossed by a white line; cilia white with a benzo brown patch near anal angle. Fore wing below dark grayish brown; costa whitish buff crossed by dark lines on outer half; some white mottlings on terminal interspaces; cilia chestnut brown mottled with white. Hind wings below white; termen dark grayish brown wide at apex, narrow at anal angle; costal margin irrorated with deep brownish drab; veins 2–4 from cell dark; traces of a double postmedial line.

Female.—Fore wing dusky drab; lines and discal spots reduced; pale greenish shading near lower angle of cell present; marginal line with greenish scaling outwardly; all the double lines with faint paler shading between them.

Expanse, male, 42 mm.; female, 50 mm.

Habitat.—French Guiana; Colombia; Mexico; Guatemala.

Type.—Cat. No. 33293, U.S.N.M.

Four males and eight females in the collection.

ELYMIOTIS LUPICINA, new species

Male.—Palpi white mottled with pale purplish gray; a fine black line near upper edge; tip of third joint white. Frons army brown becoming dark slate violet at vertex; white hairs around eyes. Collar and thorax hair brown, the tegulae mottled white and drab gray. Abdomen above light drab; a black segmental line on segment before last, a similar dorsal spot on last segment; tips of anal hairs fuscous. Fore wing light drab, the veins irrorated with black and white; a subbasal lunular black line from subcostal, outbent below cell; a double antemedial, lunular, fuscous line broken below cell, followed by a whitish shade from median to near vein 1; medial line double, fine, faint, preceded by a vertical velvety fuscous line of raised scales with a short line extending basad on fold; a large round velvety fuscous black spot at lower angle of cell, and a smaller similar spot above it; faint brownish transverse lines beyond cell; a dark shade below base of vein 5; outer line outcurved beyond cell, double, black, punctiform, partly united by a faint crenulate line from costa to vein 5 and with a triangular silvery white spot between veins 5 and 4; subterminal velvety fuscous black spots below veins 7 and 6, a larger duller spot below vein 5 at silvery spot; a submarginal fine black crenulate line, not reaching costa; cilia mottled buffish and hair brown with white points at veins. Hind wing white, the veins and termen broadly hair brown with the usual small spot at anal angle; cilia white. Hind wing below white, the termen more narrowly hair brown with some terminal white mottling, costal margin irrorated with hair brown.

Expanse 39 mm.

Habitat.—Paraguay.

Type.—Cat. No. 33299, U.S.N.M.

The subterminal spots on fore wing are unlike any other species of the group.

ELYMIOTIS DONATIAN, new species

Male.—Palpi whitish with a lateral black line, the second joint with a fine brown line below it, and a broader vinaceous-rufous line above it. Head whitish irrorated with brown and with double deep brown lines on frons. Collar argus brown with a few scattered black scales. Thorax mottled fawn color and hair brown, the tegulae dorsally suffused with brownish drab, laterally with whitish which extends on shoulders. Abdomen above light drab with a dorsal brownish drab tuft at base crossed by a black line, underneath whitish. Fore wing light cinnamon drab suffused with gray, the base and costal margin suffused with pale ecru-drab; a subbasal hazel line forming two deep lunules, double on inner margin; an antemedial vertical, velvety black line from below cell to inner margin; a medial hazel line across cell followed by broad silvery white

scaling above median to end of cell; a small black spot on discocellular; a black line on median from vein 3, extending along vein 5 to termen, partly double beyond cell, but interrupted by a silvery white streak on vein 5 beyond the fine double postmedial line; the latter is preceded from cell to inner margin by a diffuse hair brown shade; subterminal dark spots on interspaces. The entire wing is more or less covered with darker striae. Hind wing white, the termen narrowly suffused with drab.

Expanse 46 mm.

Habitat.—British Guiana.

Type.—Cat. No. 33300, U.S.N.M.

ELYMIOTIS BOISIL, new species

Male.—Palpi drab gray; a lateral fine fuscous line, the second joint crossed near tip by a broader black line. Head, collar, and mesothorax fuscous, the metathorax and tegulae, except narrowly in front, light cinnamon drab. Abdomen above drab, the basal dorsal tuft darker, underneath pale with a ventral black line. Fore wing light cinnamon drab; fine basal, and double antemedial dark lunular lines, followed from vein 1 by a velvety black thick line upcurved to discocellular and outbent along vein 5, not reaching termen where there are two small black spots above it; this line has a triangular projection below it across median fold, black points above and below it on discocellular, and a small silvery white spot on it near the end with a white projection basad; vein 1, and veins from cell and subcostal to end of postmedial area irrorated with black and white scales; a fine subterminal lunular line; terminal white points on veins; cilia with hair brown spots at veins. Hind wing white at base, the termen broadly dark cinnamon drab, its inner edge diffuse; cilia white. Fore wing below dull drab, the termen with paler shading, also the costa toward apex more narrowly. Hind wing below white, the costa and outer margin to anal angle benzo brown, not so broad as above.

Expanse 45 mm.

Habitat.—French Guiana; Amazons near Teffe.

Type.—Cat. No. 33301, U.S.N.M.

PROELYMIOTIS SEVERINA, new species

Male.—Palpi black, the first joint partly white. Frons white with two large fuscous black spots and two small spots below them; vertex and collar black, the tufts at base of antenna cinnamon brown. Thorax black, the tegulae deep slaty brown, dorsally edged in front with cinnamon brown. Abdomen above benzo brown, becoming fuscous on last segments; a black dorsal tuft at base, with diverging tufts of fuscous and cinnamon hairs; second segment with subdorsal cinnamon hairs; underneath whitish buff. Fore wing: Basal half

deep slaty brown; costa black with a double outangled fine white antemedial line; black lines in cell with fine light drab scaling between them; the subcostal vein mottled with drab and fuscous; outer edge of basal half edged with fuscous black faintly inbent, straight from costa to below cell, slightly incurved across vein 2 and outbent to inner margin where it is preceded by a small patch of vinaceous buff and cinnamon; outer half of wing shell pink shading to pinkish cinnamon on termen; an elongated fuscous black spot on costa, preceded by a black postmedial point from which a faint buffish line crosses the wing; three fine indistinct outer lines slightly inbent, the first crenulate, all with dark points on veins; a subterminal whitish line defined by cinnamon, outbent from costa to vein 7 at termen, then sinuous and bilunular on interspaces with outwardly a few dark scales forming a distinct spot on termen below vein 2. Hind wing buff white, the apex and termen somewhat suffused with cinnamon; a small fuscous spot at anal angle.

Expanse 63 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33302, U.S.N.M.

Named in honor of Mr. Edward Severin Clark.

LYSANA MINASENSIS, new species

Male.—Palpi: First and second joints ochraceous tawny, not reaching end of second joint; third joint and fringe mottled white and pale drab gray. Head, high tufts from base of antennae, collar and thorax mottled white, snuff brown and pale brownish drab. Abdomen above avellaneous with white segmental lines; anal tufts produced medially, extended laterally, light buff tipped with snuff brown; underneath light buff with faint grayish segmental bands. Fore wings vinaceous buff; a fine fuscous basal line on costa to within cell; a subbasal cinnamon drab line outcurved on costa to middle of cell, then inbent, with short projecting cinnamon brown shades below median and below a fine white line which extends through middle of cell onto base of vein 4; a double, sinous, brownish olive antemedial line on costa to white line in cell, closely followed by a finer brownish olive line outangled on subcostal, then inbent to near vein 1, with a slight twist on white cellular line, inwardly edged with white to cellular line and outwardly edged with white below it, followed from within cell by a broad brownish olive shade edged partly with fuscous scales, this shade is inangled on inner edge above fold, its outer edge incurved and has a short fuscous black line at its end in cell downbent to lower angle of cell; a similar dark streak oblique on upper part of discocellular, preceded by a dark velvety point in cell, edged with white; a double olive brown line on costa above end of cell, with

white scaling on outer side of each line; postmedial line faintly double, brownish olive, outbent on costa, excurved to near vein 5, then inbent and excurved, paler, indentate to inner margin; a white semilunular line on middle of inner margin; a fine fuscous line above vein 4, not reaching termen; a white line from costa near apex, excurved, expanding between vein 7 to termen at vein 5 preceded and followed by light brownish olive shading; below vein 5, marginal oblique white lines outwardly edged with brownish olive; cilia white mottled with hair brown, forming spots at veins. Hind wing buff white, the termen broadly benzo brown; cilia white, with dark scaling near anal angle; some dark scaling extends upward at anal angle crossed by a short silvery white line.

Expanse 32 mm.

Habitat.—Minas, Brazil.

Type.—Cat. No. 33303, U.S.N.M.

Larger than *L. postpitca* Schaus, paler, and without the golden brown markings of the latter species.

MARTHULA THOREDA, new species

Male.—Palpi and head sorghum brown, the vertex light russet vinaceous. Collar vinaceous brown. Thorax dark livid brown, the tegulae light russet vinaceous. Abdomen above sorghum brown; underneath light buff, the last two segments dark livid brown. Fore wing light russet vinaceous, the costal area broadly suffused with hay's brown, also the termen from apex to vein 3, with similar suffusions before the subbasal and antemedial lines to near vein 1, before the postmedial line on inner margin and before the outer line to vein 1; lines fine, light grayish vinaceous, the subbasal line vertical on costa, outset below cell and slightly inbent to vein 1; antemedial line double, inbent, the first line interrupted in cell by a dark round spot, the second line followed by a smaller spot in cell; reniform long, narrow, oblique, defined by a pale line; postmedial and outer lines slightly inbent from costa; a subterminal line of small black lunules on interspaces. Hind wing aeneous sorghum brown, the base and central area faintly whitish. Hind wing below buff white, the termen narrowly sorghum brown.

Expanse 37 mm.

Habitat.—St. Laurent Maroni, French Guiana.

Type.—Cat. No. 33304, U.S.N.M.

Allied to *M. quadrata* Walker.

Four males from the Dognin collection.

MARTHULA CYNRICA, new species

Male.—Palpi and body above as in *M. thoreda* Schaus; underneath the terminal segments carob brown, the anal hairs tipped with black. Fore wing light vinaceous drab, medially between lines from cell to

vein 1, also on termen from vein 3 to tornus; lines as in *M. thoreda;* costal margin and termen above vein 4 suffused with mars orange with a short brighter upright line below costa at postmedial line; deep brownish drab suffusions before outer line from vein 4 to inner margin, and before antemedial line from cell to vein 1, also along inner margin to outer line; subterminal narrow upright black spots on interspaces, below veins 3 and 2 forming lunules, outwardly pale edged. Hind wing whitish, the veins and termen diffusely cinnamon drab. Hind wing below white with a few terminal brownish scales.

Expanse 34 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33305, U.S.N.M.

Nearest *M. hirsuta* Schaus. Genitalia slides have been made of this species, and of *M. thoreda* Schaus, *M. hirsuta* Schaus, and *M. quadrata* Walker, showing distinct characters.

Genus EUDMOE Hübner

Male.—Antenna with minute fascicles of hair on basal half. Palpi long, porrect, the second joint with projecting hairs above and below, the third joint smooth. Legs smooth, the tibia well scaled; hind tibia with two pairs of long spurs. Fore wing terminally broad; costa and inner margin straight; apex acute; outer margin rounded; vein 2 towards end of cell; 3 and 4 apart; 5 from middle of discocellular; 6 from upper angle; areole very small; 7–10 on long stalk. Hind wing broad; costa slightly curved at base; outer margin rounded; the inner margin short; vein 2 from near end of cell; 3 and 4 from lower angle; 5 from middle of cell; 6 and 7 stalked; 8 close to 7 to end of cell.

Genotype.—*E. arne* Cramer.

EUDMOE CARRIETA, new species

Male.—Palpi, fore legs, mid legs partly, and tarsi brownish quaker drab; part, of mid tibia and hind legs jasper pink. Head, collar, and thorax benzo brown. Abdomen light jasper red, the base dorsally and last segment fuscous. Fore wing benzo brown, the termen broadly cinnamon brown; a faint darker subbasal line slightly mottled with grayish, followed below cell by a small cinnamon drab spot; antemedial line double fuscous, filled in with some faint dark grayish scaling becoming white from above vein 1 to inner margin; an oval cinnamon brown spot on discocellular edged with white scaling and slightly irrorated with white; a broad grayish drab shade from apex, inbent to inner margin, crossed by the fine double benzo brown postmedial line which is slightly outcurved below costa, and nearly vertical; a benzo brown shade from end of cell oblique to postmedial below vein 2; postmedial followed from vein 6 by benzo brown, defined before terminal space by slight white subterminal scaling on

interspaces; veins terminally fuscous, and termen narrowly fuscous, expanding slightly toward apex inclosing small marginal cinnamon brown spots. Hind wing fuscous black. Wings below deep mouse gray, the margins of fore wing mouse gray.

Expanse 45 mm.

Habitat.—Nova Olinda, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33306, U.S.N.M.

Named in honor of Mrs. W. J. (Carrie) Holland.

LEPASTA BRANDA, new species

Male.—Palpi russet with a few scattered white hairs; tufts at base of antenna mummy brown mottled with white hairs. Head white behind. Collar warm buff mottled with white and mummy brown. Tegulae white irrorated with mummy brown, and a lateral mummy brown streak. Metathorax with white tufts. Abdomen above whitish largely suffused with wood brown; lateral down turned light buff hairs; venter white. Fore wing: Costa raw umber, not reaching apex; base of cell and inner margin to cell and vein 2 white irrorated with olive brown; an antemedial thick, short black streak above vein 1; a pure white line in outer half of cell anteriorly continued and slightly downcurved on and below vein 5, upturned to vein 7, then downbent to near vein 6 at subterminal line, with a brownish olive shade before it on costa, continued below it to vein 2 and somewhat upbent to termen at vein 3; this dark shade encroaches on white line at lower angle of cell; a fine black subterminal line wavily crenulate; interspaces above veins 5 and 7 whitish irrorated with olive brown. Hind wing and cilia drab. Fore wing below suffused with drab. Hind wing below: Margins broadly white, the intermediate space benzo brown extending on to termen between veins 3 and 4.

Expanse 30 mm.

Habitat.—São Paulo de Olivença, Amazons.

Type.—Cat. No. 33307, U.S.N.M.

Two males from the Dognin collection.

Somewhat like *L. mascella* Schaus and *L. pittieri* Schaus; these two species described under *Antiopha* must be removed to *Lepasta*.

DASYLOPHIA BLAIZEA, new species

Female.—Palpi: Second joint with a black line above, and a grayish line below it, the fringe light buff with some wood brown mottling; fringe on first joint white. Frons wood brown; a white mark on tuft at base of antenna; collar wood brown, with some chestnut brown in front. Thorax mostly white, the tegulae dorsally white, laterally pinkish buff. Abdomen above drab with white segmental lines, the last two segments white with drab irrorations; underneath white irrorated with drab. Fore wing mostly pinkish buff suffused with avellane-

ous on basal third of costa; a series of black points medially below costal edge; a double medial wood brown line slightly outbent and united at lower angle of cell, preceded on costa by a buffy brown shade, below cell inbent to a black spot above fold which is the end of a black line from vein 1 near basal area, with a finer black line below it; inner margin rather thickly irrorated with black below vein 1 to tornus, except on basal area; an outcurved postmedial wood brown line from costa to the black spot below cell, then downbent to middle of inner margin; a similar evenly curved outer line, faintly double to a dark spot below vein 2, followed between costa and vein 5 to termen by a hazel shade on which the veins are finely black and with whitish intranerval lines edged with black, sharply pointed basad; a fuscous terminal patch between veins 2 and 4, mottled with brown and with a white spot above vein 2 at outer line and a pale marginal angled line broken by vein 3. Hind wing white; veins terminally avellaneous; a very fine terminal avellaneous line.

Expanse 58 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33308, U.S.N.M.

In long series of the variable *D. xylinata* Walker, and *D. maxtla* Schaus, I can find no females with entirely white hind wings. The postmedial and outer evenly curved and parallel lines are also a distinct character.

FARIGIA LIBORIA, new species

Male.—Palpi above brown, laterally and below mottled vinaceous buff and white. Head, thorax, and abdomen above liver brown mottled with white hairs. Abdomen below light buff. Fore wing russet irrorated with white and greenish white scales; a broad antemedial fascia, rejane green edged with irregular natal brown lines; a small black and whitish mark on discocellular; postmedial line double, natal brown, filled in with Lincoln green, vertical, slightly sinuous from costa to vein 2, then slightly inbent, followed on costa by a clearer quadrate brown spot; subterminal line natal brown, irregular; termen and inner margin below vein 1 irrorated with Lincoln green, more thickly on inner margin. Hind wing pecan brown, the cilia tipped with white.

Expanse, male, 38 mm.; female, 43 mm.

Habitat.—Amatura, Teffe, Amazons; French Guiana.

Type.—Cat. No. 33309, U.S.N.M.

The contrast between the clear medial space and the green markings is very conspicuous.

FARIGIA LUICANA, new species

Male.—Palpi hazel, the fringe below tipped with white. Head, collar, and thorax hazel thickly mottled with white hairs. Abdomen

above cinnamon mottled with white hairs, underneath light buff. Fore wing: Basal third of costa and cell white with some hazel scattered scales; below cell mostly glaucous; antemedial line glaucous, defined by natal brown scales, curved at costa near middle and inbent to inner margin; space beyond to postmedial mottled hazel and white with some glaucous scaling around discocellular and on inner margin; a sulphur yellow spot below costa before postmedial; two dark lines indicating discocellular spot; postmedial line slightly outcurved, fuscous, somewhat macular to submedian fold, followed by faint traces of a paler second line; termen irrorated with glaucous, but very slightly so between veins 4 and 6; subterminal line irregular, fuscous; some white scaling on cilia. Hind wing pecan brown, the cilia tipped with white.

Expanse, male, 34 mm.

Habitat.—Lino, Panama.

Type.—Cat. No. 33310, U.S.N.M.

Described from three males.

FARIGIA THELIAN, new species

Male.—Palpi chestnut brown above, laterally avellaneous, below white. Head, collar, and thorax white mottled with army brown hairs. Abdomen above fawn color with army brown dorsal tufts on three basal segments; underneath light buff. Fore wing white thickly irrorated with fawn color especially on terminal third; an oblique chestnut brown basal line from below costa to submedian fold and a black line edged with chestnut brown from it along submedian fold to just beyond postmedial line; a medial hazel line, straight to vein 1, then double, lunular, on inner margin followed by a narrow russet shade; a black point on discocellular; postmedial line double, fine, hazel, slightly outcurved from costa, followed by some darker spots from vein 3 to inner margin; an irregular subterminal fine hazel line, consisting of oblique streaks below veins 4 and 3; the base of inner margin white. Hind wing buckthorn brown; cilia tipped with white. Wings below light buff, the fore wing suffused with light pinkish cinnamon; some hazel cilia on costa of hind wing before apex.

Expanse 47 mm.

Habitat.—Buena Vista, Colombia.

Type.—Cat. No. 33311, U.S.N.M.

FARIGIA ALICIA, new species

Male.—Palpi chestnut brown above, white below. Head and thorax cinnamon brown mottled with white hairs chiefly on tegulae. Abdomen above chestnut brown thickly overlaid with white scales except on segmental lines; a dorsal chestnut brown tuft at base; underneath light buff. Fore wing: Base and inner margin broadly to tornus

Rinman's green, the wing otherwise white thickly irrorated with chestnut brown especially on terminal area; a double, deeply angled, dark subbasal line; antemedial line double, dentate, inbent from costa to below cell, then single, outbent, lunular to near middle of inner margin; a fine black line on submedian fold to postmedial line; a small white spot with a few black scales on discocellular; a faint dark lunular line crosses the wing beyond cell, followed by the more distinct double lunular postmedial line, the outer part thicker, black from submedian fold to inner margin; beyond are some whitish oblique shades on interspaces from vein 6 to vein 2; subterminal line fine, black, outbent from costa to vein 6, vertical to vein 4, below 4 broken into oblique lines outwardly shaded with white, cilia with white points at veins. Hind wing fawn color, narrowly darker on termen; cilia white. Fore wing below shaded with fawn color, the hind wing light buff.

Expanse 42 mm.

Habitat.—Songo, Bolivia.

Type.—Cat. No. 33312, U.S.N.M.

FARIGIA SENNEN, new species

Male.—Palpi buffish edged above with blackish brown. Head and thorax liver brown mottled with white hairs, the collar only tipped with white. Abdomen above liver brown, white hairs forming segmental lines, the two terminal segments and anal hairs whitish; underneath light buff. Forewing: An outcurved fascia from base below costa, liver brown irrorated with pale green scales, the base of costa and inner margin buffish, the former irrorated with liver brown and with two similar outbent short lines; antemedial space and inner margin to tornus thickly mottled with light green scales, on inner margin limited above by a curved black line from antemedial to postmedial, with a similar shorter line along vein 2; antemedial line liver brown, wavy, not distinct; upper portion of wing medially whitish with a few liver brown irrorations; a raised white point on discocellular with a few black scales on inner edge; a drab line crosses the wing beyond cell, closely followed by a liver brown lunular line, outbent on costa, slightly inset at vein 4, then vertical to inner margin, a narrow whitish shade preceding it on inner margin; terminal area light cinnamon drab with some diffuse whitish marks; subterminal line fine, hair brown, irregular, outwardly partly shaded with white; some white hairs on cilia. Hind wing army brown, the cilia tipped with white.

Expanse 37 mm.

Habitat.—Maroni River, French Guiana; São Paulo de Olivença, Amazons.

Type.—Cat. No. 33313, U.S.N.M.

Nearest *F. magniplaga* Schaus.

SYMMERISTA SIGEA, new form

Male.—Body and forewing as in *S. tlotzin* Schaus. Hind wing at base and on inner margin white suffused with light buff; veins drab; outer margin from middle of costa dark hair brown, becoming narrower at anal angle; cilia white. Hind wing below with the hair brown on costa to base, irrorated with white scales from base to apex; outer margin and cilia as above.

Expanse 36 mm.

Habitat.—Coary, Amazons.

Type.—Cat. No. 33314, U.S.N.M.

A male and a female from the Dognin collection.

CERURA PURUSA, new species

Male.—Palpi black. Head white, the eyes fringed with black hairs which extend along frons above palpi. Collar and thorax white, a black line across front of thorax expanding somewhat dorsally; two small dorsal spots, and two larger spots on metathorax. Abdomen above black, base, terminal segment, laterally and ventrally white; a black line on anal hairs, not meeting dorsally. Fore wing silvery white, the markings black; a triangular spot at base, its apex at base of cell, its outer edge excurved and with an outbent line to cilia on inner margin; a small triangle at middle of inner margin filled in with warm buff; a short upturned line from inner margin postmedially with black and buff scaling on its outer edge; a round spot at middle of cell filled in with warm buff, and a bifurcating line on costa above it; a small streak on costa above discocellular; and outer thick line, from above vein 4, sinuous to costa, with another line close beyond from vein 6 excurved and outbent on costa, a white spot between them on costa, and warm buff scales between veins 8 and 6, these continuing along the outer edge of first line to its end; terminal black lunules on interspaces including cilia; at veins the cilia are white. Hind wing white, semihyaline in cell and interspaces beyond cell.

Expanse 34 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33315, U.S.N.M.

Closely allied to *C. trigonostigma* Dyar from Mexico.

PEROARA CATERINA, new species

Female.—Head, collar, and thorax benzo brown mottled with white hairs especially on tegulae, the base of the hairs, laterally on tegulae, buff, also a long tuft of buff hairs on dorsal side in front. Abdomen pale ochraceous buff, the basal dorsal tuft natal brown; some hazel scaling sublaterally towards end of abdomen. Fore wing: Base of

costa and cell to double medial line benzo brown mottled with white and buff scales, limited below by a fuscous line, outbent from base of subcostal to median vein; base of inner margin white irrorated with fuscous and natal brown scales; inner margin to above vein 5 mottled white and natal brown, crossed by two dark medial lines and the white postmedial and subterminal lines; the double dark medial line slightly incurved, partly crossing a large fuscous spot in cell; a triangular white and buff space over end of cell and discocellular, its apex at vein two, its base on subcostal, slightly irrorated with natal brown, the costa above it natal brown thickly irrorated with white; postmedial line double filled in with whitish on costa, with clear white on inner margin, outbent and sinuous on costa, inbent along vein 6, then deeply lunular dentate to vein 2; a subterminal white shade preceded by a dark space on costa, with fuscous streaks above and below vein 7, expanding towards cell between veins 6 and 4, then narrow to vein 2 and outbent to tornus; a fine terminal white line; cilia morocco red, cut by yellowish fine lines at veins; the tips of cilia yellowish. Hind wing buffish suffused with fawn color, the termen broadly army brown; an indistinct medial and postmedial darker shade; cilia tipped with white.

Expanse 51 mm.

Habitat.—Blumenau, Brazil.

Type.—Cat. No. 33316, U.S.N.M.

PSILACRON CONGALLA, new species

Male.—Head, collar, and thorax light brownish olive. Abdomen above drab with fine dark segmental lines; some olive buff anal hairs; underneath olive buff with ventral black spots on all the segments. Fore wing suffused with olive ocher; base of costa finely dark purple drab; a similar streak along upper edge of cell to antemedial line; transverse lines sayal brown, on costa fine; antemedial line double, sinuous, interrupted; medial line wavily outbent and angled between veins 3 and 4 at postmedial, then inbent to middle of inner margin between two small round white spots above vein 1, these spots more darkly edged; a faint pale grayish shade above and below vein 3 at cell; postmedial line double, below costa mostly light yellowish olive, deeply outcurved at vein 6, inbent and lunular to fold, then sinuous, vertical to inner margin; some light vinaceous gray scaling irrorated with black following postmedial between veins 5 and 4; a cinnamon shade from apex, inbent and expanding at vein 5 crossed by a sayal brown subterminal line which is wavy, broken, ending in an outbent dark line from vein 2 to vein 1 with black points on these veins; a few black hairs on cilia at veins. Hind wing whitish buff suffused with hair brown forming a broad shade on outer margin; cilia whitish suffused with olive ocher.

Expanse 34 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33317, U.S.N.M.

Somewhat like *P. luteovirens* Felder, the fore wing broader, the outer margin rounded; also smaller.

PSILACRON GORDIANA, new species

Male.—Head, collar, and thorax yellow ocher, the tegulae mottled with drab gray. Abdomen above ochraceous buff on two basal segments, beyond suffused with fuscous; anal hairs warm buff; underneath warm buff, a ventral black spot near base and one on last segment. Fore wing mostly warm buff; antemedial and medial lines zinc orange, the former double, outcurved to middle of inner margin, preceded by mouse gray scaling on inner margin irrorated with black, and some black scales above vein 1; the medial line outbent, angled at vein 4 and inbent to middle of inner margin, cinnamon irrorated with black on costa; postmedial fine, double, outbent from costa to vein 6, vertical to vein 4, and inbent to vein 2 below which it is vertical to inner margin; apical area suffused with sayal brown; subterminal black spots from costa to below vein 4, the two spots nearest costa placed on small trigonate buff yellow spots. Hind wing suffused with drab; some white suffusions at base, and a whitish postmedial line inwardly edged by a fine black line; cilia warm buff.

Expanse 49 mm.

Habitat.—Monte Tolima, Colombia.

Type.—Cat. No. 33318, U.S.N.M.

This species is closely allied to *P. luteovirens*, but larger, with darker hind wing and the fore wing broader, the outer margin rounded as in *P. congalla* Schaus.

URGEDRA OSLACA, new species

Female.—Head, collar, and thorax, hessian brown; a few white hairs on collar; a transverse whitish line on metathorax. Abdomen above fuscous, underneath mars brown. Fore wing hessian brown; some baryta yellow scales on costal margin, and four oblique costal lines toward apex; a fuscous subbasal line outbent below cell to vein 1; a faint antemedial fuscous line, outangled on fold, followed by some white and baryta yellow scaling around angle; an irregular white and yellowish oblique line on discocellular; a subterminal white line indentate on veins 5 to 1 mottled with baryta yellow at veins, followed narrowly by hessian brown scaling on interspaces; a terminal hessian brown line, inwardly edged by bluish white scales, interrupted by veins; the veins terminally baryta yellow irrorated with hessian

brown, this coloring extending on cilia, which are hessian brown on interspaces, and crenulate. Hind wing dark cinnamon drab; cilia tipped with white, and with yellowish points at veins. Wings below sorghum brown, the cilia darker with whitish yellow spots at veins.

Expanse 50 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33319, U.S.N.M.

URGEDRA NABORA, new species

Male.—Head, collar, and thorax mottled ocher red and white, the white predominating on collar; tegulae light cinnamon drab. Abdomen above light drab, paler laterally. Fore wing light cinnamon drab; some pale veronese green metallic scaling below subcostal on basal third, similar scaling before antemedial line broadly, and also broadly before outer line, diminishing toward costa; subterminal small chestnut brown lunules, with some metallic scaling, increasing at tornus; antemedial almost evanescent, except from fold to inner margin, outcurved, somewhat lunular, sayal brown to fold, below it chestnut brown; a faint medial, and a double postmedial sayal brown line; outer line slightly incurved from below vein 4, fine, chestnut brown, outwardly edged with white; a fuscous point in middle of cell; a dark line on discocellular. Hind wing tawny, the base and costa broadly whitish; cilia mottled white and tawny.

Expanse 37 mm.

Habitat.—Monte Tolima, Colombia.

Type.—Cat. No. 33320, U.S.N.M.

Near *Urgedra viridiflava* Dognin = *U. luceria* Druce, in which the green scaling is dull.

From the Dognin collection.

DICENTRIA FECHIMA, new species

Male.—Palpi and frons light pinkish cinnamon, the palpi streaked above with fuscous. Vertex, collar, and thorax mottled cinnamon buff and chestnut, the tegulae laterally suffused with fuscous. Abdomen above hair brown, the base and last two segments light pinkish cinnamon, underneath buff white. Fore wing: Base obliquely and inner margin cinnamon, followed by a black space to postmedial; a narrow cinnamon streak above fold from base; a long curved cinnamon buff spot on outer half of cell, crossed by a fine double medial line, and a cinnamon line at discocellular; costa from before middle light ochraceous buff, expanding from postmedial to apex; postmedial consisting of a blackish outcurved shade followed by cinnamon scaling on interspaces from vein 2 to vein 6, and some white scaling on veins; terminal area prout's brown, inwardly darker shaded; subterminal dark spots below costa; cilia pinkish buff with dark spots at veins. Hind wing white; costa light drab; veins terminally irrorated with

cinnamon brown, and similar scales on termen; some dark scaling at anal angle and a dark streak extending toward base; the inner margin whitish buff; cilia white.

Expanse 37 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33321, U.S.N.M.

Nearest *D. limosoides* Schaus = *claricostata* Dognin.

SCHIZURA SALVADOR new species

Female.—Palpi fuscous fringed with white. Head, collar, and thorax mottled white and fawn color. Abdomen above light cinnamon drab suffused with cinnamon at base, underneath white irrorated with light cinnamon drab. Fore wing bister, the veins black; a black streak at base below cell; a round black spot between veins 2 and 3 at cell; verona brown streaks on interspaces beyond cell, and a similar streak below middle of cell and vein 2; cilia white with dark spots at veins. Hind wing white, the veins beyond cell and termen aeneous sayal brown, rather darker at anal angle; cilia white except at anal angle. Hind wing below white with a snuff brown spot at anal angle.

Expanse 40 mm.

Habitat.—San Salvador.

Type.—Cat. No. 33322, U.S.N.M.

From the Dognin collection.

LITODONTA CENTIGERNA, new species

Male.—Palpi army brown, somewhat darker above. Frons mottled cinnamon drab and white. Vertex fuscous, collar and thorax pale drab gray mottled with drab and cinnamon drab. Abdomen white irrorated with cinnamon, more densely toward base, forming transverse bands; underneath white. Fore wing largely white, the lines benzo brown; a faint subbasal line; antemedial space snuff brown mottled with white below cell; antemedial line double outcurved to median, the inner line with projecting streaks above and below median to near base, below cell deeply outangled below fold, and again on inner margin; medial space to postmedial snuff brown on costa, otherwise partly irrorated with brown, crossed by a fine incurved line in cell; postmedial army brown with some fuscous scaling, double, outangled at vein 7 and vein 3, inangled at discocellular and vein 5, below vein 3 incurved; veins from cell fuscous; interspaces suffused with buffy brown, outwardly defined by a white, deeply dentate subterminal line, a fine fuscous marginal line; cilia partly white. Hind wing white; inner margin broadly, termen narrowly fawn color; cilia white.

Expanse 27 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33323, U.S.N.M.

NOTOPLUSIA MARCHIANA, new species

Male.—Very similar to *N. clara* Cramer. Antenna fasciculate on basal half instead of being shortly pectinated. Forewing differs in having the subterminal broad black line lunular on interspaces, with only one lunule from vein 6 to vein 4, followed by a fine lunular chestnut line, interrupted by veins; terminal chestnut lunules, expanding at veins. Hind wing whitish, the margins suffused with drab narrowly so on outer margin.

Expanse 40 mm.

Habitat.—Buenavista, eastern Andes, Colombia.

Type.—Cat. No. 33324, U.S.N.M.

Another male from Rio Songo, Bolivia, has the hind wing almost completely white.

Genitalia slides have been made of these two specimens and of *N. clara* Cramer, showing them to be absolutely different.

From the Dognin collection.

NOTOPLUSIA TALMECANA, new species

Male.—Palpi fuscous above, buff white below. Head, collar, and thorax vinaceous buff; a medial line of olive brown and cinnamon hairs from vertex to metathorax. Abdomen above chestnut drab, the last two segments and anal hairs buff white with a few dark irrorations; underneath white. Forewing tilleul buff; a white line on median to vein 3, narrowly edged in cell with sayal brown, and below cell with antimony yellow; below this a mouse gray streak and a streak in cell, both irrorated with black; similar suffusions medially from fold to inner margin; an interrupted dark, outbent subbasal line; traces of an antemedial line on costa with a few black scales on subcostal; a postmedial dusky narrow shade, outbent on costa, incurved below vein 2; a very faint outer dentate line, except from costa to vein 6, where the angles are filled in with fuscous, outwardly edged with white, below vein 6 are fuscous points, followed by whitish and then by short fuscous streaks on veins; a faint dusky shade from cell along vein 5 to termen; terminal fuscous points on interspaces; cilia white, with fuscous streaks at veins. Hind wing drab; cilia white suffused with drab at base.

Expanse 35 mm.

Habitat.—Nova Olinda, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33325, U.S.N.M.

In general appearance very much like the species of *Talmeca*.

MISOGADA BRIOCA, new species

Female.—Antenna pectinated on basal half. Palpi cinnamon brown above, the third joint and fringe white. Head, collar, and thorax white mottled with buffy brown; two tufts on metathorax partly edged with fuscous, the center irrorated with iridescent scales. Abdomen above white irrorated with buffy brown, and with some buff brown hairs at base; underneath white. Fore wing white, thinly irrorated with buffy brown, more so on inner margin and costa medially; traces of a subbasal dark line; antemedial line double, fine, the inner part hardly traceable below cell, the outer part well defined, buffy brown irrorated with fuscous, outbent on costa, dentate, inbent from middle of cell, outbent, even from median to near vein 1, inangled and outbent to inner margin near postmedial; a fine dark curved line on discocellular, inwardly edged with clear white; postmedial line benzo brown from an elongated fuscous shade on costa, inbent, crenulate, incurved from veins 8–4, then outbent, and again incurved from vein 2 to vein 1, followed by a narrow buffy brown shade; a subterminal hair brown shade from below costa, narrower from vein 4 to tornus; a very wavy marginal fuscous line. Hind wing whitish, the outer margin thickly irrorated with buffy brown.

Expanse 31 mm.

Habitat.—San Ignacio Mission, Argentine Republic.

Type.—Cat. No. 33326, U.S.N.M.

From the Dognin collection.

TRUMANDA SCHIFFI, new species

Male.—Palpi black fringed with white. Head cream white. Collar and thorax white mottled with a few drab hairs. Abdomen above cream white; anal tufts mottled with hair brown. Fore wing white; costa with small mouse gray spots at origin of lines; patches of drab irrorations at base and on antemedial area from subcostal to vein 1; a mouse gray subbasal line, outbent and angled on fold, inwardly edged with clear white, followed on inner margin by a mouse gray patch; antemedial line double, across cell black, below cell mouse gray somewhat incurved, filled in with white to vein 1 below which is a round mouse gray spot; end of cell dull white; discocellular with a black bar; veins 3–8 from cell black to subterminal line; between veins 4–8 the interspaces dull white, appearing semihyaline, crossed by a fine double incurved postmedial black line, which on costa is rather vague, outbent, mouse gray, below vein 4 inbent, diverging, the inner line doubled by a line from base of vein 3 and incurved to inner margin, the outer part outset, lunular, also mouse gray; from vein 2 beyond its base an ochraceous orange and tawny bar not reaching vein 1, and a similar spot below vein 5 at discocellular; subterminal thick black spots outbent from

costa to vein 6, inbent below it to vein 4, followed by a sinuous white line edged below vein 4 on either side with hair brown; a fine marginal line, straight and inset on each interspace; terminal hair brown irrorations at tips of veins; cilia white with hair brown spots at veins. Hind wing semihyaline white below vein 6 and lower part of cell; costal margin broadly white; a postmedial black line from costa to vein 6; inner margin broadly light buff. Wings below white; costa of fore wing fuscous for two-thirds from base; costa of hind wing broadly black.

Expanse 48 mm.

Habitat.—Buena Vista, Colombia.

Type.—Cat. No. 33327, U.S.N.M.

Named in honor of Mr. Mortimer L. Schiff, a generous contributor to the Dognin fund.

DISPHRAGIS CLITIUSA, new species

Male.—Palpi fuscous above and laterally, fringe and tip of second joint whitish buff. Collar cinnamon in front, whitish buff behind. Thorax drab suffused with light vinaceous drab. Abdomen above drab, suffused with brown towards base; underneath white or light drab according to light. Fore wing drab mottled with cinnamon drab; a darker shade from base below streak to medial line at vein 1; a fine double subbasal line outangled on costa, lunular below cell with a short black streak on it from base below cell; a cinnamon patch antemedially on costa; a double medial line below cell partly traced with black scales, lunular, deeply indentate just below cell and on vein 1, inbent and sinuous on inner margin; a fine dark incurved line on discocellular touched at either end by a more heavily outcurved black postmedial line, almost vertical from vein 2 to vein 1, then fine and outbent, crossed above vein 2 by a faintly downcurved thick black line to near termen, and by a fine black line from discocellular above vein 4; traces of a similar line above vein 5; a fine double outer line very faint, irregular and interrupted; a whitish subterminal line inwardly edged with black between veins 8 and 6 and a small black spot above vein 3; fine marginal and terminal dark lines. Hind wing white, the costal margin drab crossed by three dark lines toward apex, and a whitish line before the last; inner margin suffused with drab.

Expanse 45 mm.

Habitat.—Joinville, Brazil.

Type.—Cat. No. 33328, U.S.N.M.

Near to *D. daona* Druce, larger, paler, the line above vein 2 straighter, the subterminal line less distinct.

Three males in the United States National Museum, two from the Dognin collection.

DISPHRAGIS EPIMACHA, new species

Female.—Palpi fuscous streaked above, laterally light buff, the fringe buffy brown. Head, collar, and thorax mottled light buff and vinaceous cinnamon, the tegulae dorsally and metathorax with some fuscous and drab scales. Abdomen above light drab on basal half, the terminal half vinaceous buff; some fine dark segmental lines; underneath vinaceous buff with dark segmental lines. Fore wing: Basal half mostly sayal brown; base grayish limited by a double black line from a small orange spot near base of median vein, outbent to vein 1, and filled in with white; antemedial line fine, black and outbent on costa, then oblique wavy lunular to the fine medial black line at inner margin; postmedial fuscous line incurved from subcostal to vein 3 followed by a large buffish white spot, partly suffused with warm buff which narrows and reaches costa before apex. This space is indentated at its middle by a brown space on costa, its outer edge is limited by a cinnamon brown subterminal sinuous shade, which encroaches upon it between veins 6 and 4, below vein 4 the subterminal is velvety fuscous, outcurved to below vein 3, inangled, and outangled below vein 2; the pale space is crossed near cell by a fine curved cinnamon line, and by a partly double cinnamon brown outer line, which on costa is outbent and filled in with white; terminal antimony yellow spots on interspaces preceded by some diffuse hair brown shading and crossed by a fine cinnamon brown line; vein 1 and veins from cell partly irrorated with black and white; cilia tipped with ochraceous buff on interspaces; postmedially below vein 2 is a smaller buffish white space. Hind wing dark buffy brown; a faint postmedial pale line, ending at a small white spot on inner margin above anal angle; cilia white with dark spots at veins.

Expanse 43 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33329, U.S.N.M.

DISPHRAGIS MARUSA, new species

Female.—Palpi mottled wood brown and white, streaked above with fuscous. Head and collar mottled light buff and pecan brown. Thorax mottled brownish drab and light buff, the lateral tuft of tegulae dark grayish brown. Abdomen above dark grayish brown, except at base and on two last segments which are whitish irrorated with cinnamon and cinnamon drab; dorsal tuft at base dark grayish brown; underneath drab. Fore wing mostly sayal brown; base of costa to below cell and inner margin medially suffused with cinnamon buff; an irregular cinnamon brown subbasal line; costa medially mottled olive buff and light yellow crossed by three dark lines; a faint double medial dark line, very fine, vertical from subcostal to vein 1; a white crescent on discocellular divided by a fine cinnamon brown line

inwardly edged by a narrow dark shade which is downcurved to vein 2 and termen; postmedial line cinnamon brown, from costa above discocellular where each line is outwardly edged with white, outbent along vein 11, downbent, lunular and vertical to vein 3, then incurved to inner margin near tornus; some sayal brown and hair brown mottling between crescent and postmedial line; some greenish and whitish yellow mottling beyond postmedial from vein 3 to costa at apex; the cinnamon brown line on crescent is continued across lower angle of cell and downcurved to vein 2 and subterminal line which is also cinnamon brown outwardly edged with white, indentate between veins 6 and 4, outset on 4 and curved to join line from crescent, with traces of the line below vein 2; the subterminal is followed by a broad fuscous shade which becomes narrower and broken below vein 3, then by a light dull green yellow thick line, cut by the fuscous veins and edged by a wavy fine black line; termen from apex to vein 3 narrowly brownish drab, below vein 3 to tornus light yellowish green, terminally edged by a faint black line; cilia light brownish drab with fuscous spots at veins; there is a whitish space postmedially from vein 2 to vein 1. Hind wing dark drab; a faint white postmedial line; cilia whitish with faint dark spots at veins. Hind wing below whitish; a discal spot, broad medial shade, and termen broadly drab.

Expanse 41 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33330, U.S.N.M.

The nearest allied species is *D. altilis* Schaus.

DISPHRAGIS ARIMA, new species

Male.—Palpi black above, fringe mottled buffy brown and whitish. Collar brownish olive, broadly fuscous behind with white tipped hairs on posterior edge. Thorax mottled buffy olive and brownish drab. Abdomen above dark grayish brown; dorsal crests dusky brown; last segment tawny olive. Fore wing light brownish olive slightly irrorated with black; a double, curved, subbasal black line; antemedial and medial lines indistinct, fine, black, dentate; a fine fuscous line on discocellular edged with fawn color; a fine dark dentate line outcurved beyond cell, closely followed by the similar double postmedial line, the latter with white spots on veins along its outer edge, and a series of fuscous and tawny small streaks on interspaces, the one below vein 3 larger; a fuscous and orange cinnamon streak along inner margin before middle; a faint subterminal dark line, lunular or oblique on interspaces; veins from cell irrorated with black and white; a fine dark terminal line with whitish points on veins; cilia light brownish olive with dark spots at veins. Hind wing: Inner and outer margins broadly drab; lower part of cell and interspaces beyond

whitish; costal margin light brownish olive crossed by a double postmedial and a subterminal black line; a punctiform postmedial faint line; cilia buffy olive tipped with white and with dark hairs at veins.

Expanse 40 mm.

Habitat.—Arima, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33331, U.S.N.M.

Closely related to *D. vestona* Schaus; the hind wing quite different.

DISPHRAGIS SABARIA, new species

Male.—Palpi fuscous black above, brown laterally and below, but white toward tip of second joint, and on third joint. Frons buffish; some cinnamon buff between antennae. Vertex, collar, thorax, and basal tuft on abdomen prout's brown. Abdomen above drab partly overlaid with cinnamon drab, the last segment mottled with white; underneath pale drab gray. Fore wing: Base obliquely from costa to a black medial streak on inner margin, buckthorn brown; costa and cell to beyond discocellular, and below cell to vein 1 and medial line white irrorated with ochraceous tawny; a faint double fine line on costa; medial line, double, cinnamon brown, outbent from before middle of costa to beyond middle of inner margin, filled in with white, irrorated in cell with black; a small black spot in cell toward end; some black scaling on discocellular partly edged outwardly with whitish; outer space beyond largely buckthorn brown, darker toward apex; a fuscous shade between veins 4 and 5 and from vein 3 to fold; a fuscous double line on costa above discocellular; postmedial line remote, faint, cinnamon brown, partly irrorated with black, incurved betweeen veins 7 and 4, and below vein 3; subterminal line pale and fine from costa to vein 5, then broader, white, lunular to vein 2; veins from cell mostly black; cilia tipped with white and with black spots at veins. Hind wing suffused with benzo brown; a double darker postmedial line, followed by a faint whitish band; costal margin and cell whitish buff; the postmedial lines on costa cinnamon brown; veins from cell black; cilia tipped with white. Hind wing below buff white.

Expanse 50 mm.

Habitat.—Mana River, French Guiana.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33332, U.S.N.M.

DISPHRAGIS HYGINIA, new species

Male.—Palpi buffy brown above, white below mottled laterally with buffy brown. Frons white with some cinnamon scaling. Vertex fawn color. Collar deep brownish drab, crossed by a black line. Thorax cinnamon brown, the tegulae deep brownish drab. Abdomen

above cinnamon brown the last two segments white irrorated with cinnamon brown; underneath white with pale ecru drab segmental lines. Fore wing dark buckthorn brown with an olivaceous tinge, possibly vivid green when fresh; a large triangular white space from base to middle of costa, narrowing to vein 1 before middle of inner margin; traces of a double antemedial ochraceous tawny fine line; a similar double medial line, inbent on costa, interrupted in cell, lunular and vertical from median to vein 1; a fuscous spot at end of cell; an outcurved cinnamon brown line around end of cell; some fuscous scaling between veins 2 and fold from medial to postmedial line, this latter double, somewhat lunular, inbent from costa; white spots on termen from above vein 4 to vein 2, partly cut by some marginal buckthorn brown scales, the white extending on cilia, which are otherwise only tipped with white. Hind wing white, thinly scaled on interspaces below vein 7; some brownish scaling on inner margin; costa opaque white with a double postmedial buckthorn brown line, and small spots at apex.

Expanse 46 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33333, U.S.N.M.

A very distinct species.

DISPHRAGIS DRUONA, new species

Male.—Palpi black, the fringe buffy white. Head, collar, and thorax mottled light yellowish olive and buffy brown. Abdomen above drab, underneath light buff. Fore wing light yellowish olive; double basal, antemedial and medial fine fuscous lunules on costa; cell and base to antemedial thickly irrorated with black; a black, diffuse fascia from lower angle of cell, oblique, expanding to marginal line from vein 3 to vein 1; a fuscous line on discocellular; postmedial line lunular dentate, outbent on costa, followed on veins by white and black points, the veins beyond black irrorated with white; a diffuse benzo brown subterminal shade, expanding somewhat between veins 4 and 6; a marginal lunular black line from vein 7 to inner margin; a terminal darker green line with a few black scales; cilia tipped with white, and with black spots at veins. Hind wing hair brown, the costal margin broadly dull green, crossed by a double, wavy, fuscous, postmedial line, and a dusky subterminal shade; cilia green tipped with white and with dark points at veins.

Expanse 37 mm.

Habitat.—French Guiana.

Type.—Cat. No. 33334, U.S.N.M.

Two males in the Dognin collection.

DISPHRAGIS CARANTIS, new species

Male.—Palpi buff in front, black laterally. Head, collar, and thorax reddish brown. Collar behind dark with some white tipped scales at center; shoulders and tegulae shaded with dull green. Abdomen above fuscous brown. Forewing: Costal margin dull green with black lines and black points toward apex; below costa the wing is chiefly purplish brown with a light brown shade from discocellular to apex; some luteous hairs at base of inner margin; a light brown streak at base below submedian and a black streak below it to antemedial line; antemedial line black with a white point on submedian and one below it; a dull green streak on discocellular partly edged with white; postmedial indistinct, black, with minute white points on veins; the veins terminally black with a few white irrorations; subterminal fuscous streaks and spots; a terminal green line cut by the veins and outwardly edged with black; cilia mottled fuscous and light brown. Hind wing fuscous, the veins darker; an indistinct pale straight postmedial line; costal margin tinged with green and brown above vein 7 with a dark medial streak, and a dark streak before the postmedial line. Forewing below fuscous gray, the veins darker except on termen and inner margin which are narrowly white. Hind wing below whitish; some terminal greenish irrorations; cilia white with fine black streaks at veins.

Expanse 36 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33335, U.S.N.M.

DISPHRAGIS AGAPA, new species

Male.—Palpi black above and laterally, the fringe and hairs on legs mottled white and buffy brown. Head, collar, and thorax mottled avellaneous and pale drab gray. Abdomen above light buff suffused with drab. Fore wing: Base fuscous mottled with drab close to thorax and on inner margin, limited by the black antemedial line which is deeply outbent in cell, inangled below cell then wavily outbent; medial area grayish on costa, light cinnamon drab at lower part of cell and below cell to inner margin, below vein 2 expanding to beyond postmedial line; a fine velvety black line, incurved along discocellular and on median to vein 2, somewhat punctiform; a broad fuscous shade beyond cell from vein 8 to vein 2 and tornus, its outer edge irregularly incurved, outwardly edged by the fine fuscous black postmedial line, which is inangled at vein 5, sinuous to vein 2, then incurved; a broad oblique white spot from vein 5 to near apex, followed by fuscous spots; termen mottled fuscous and wood brown; a marginal fine dark line, somewhat lunular. Hind wing white, the termen drab; the hairs on inner margin whitish buff; cilia white.

Expanse 28 mm.

Habitat.—Venadio, Sinaloa, Mexico.

Type.—Cat. No. 33336, U.S.N.M.

The species is close to *D. subrotata* Harvey and may prove to be the same species when more material is examined.

DISPHRAGIS PSALMOIDA, new species

Male.—Head and body dull green; tufts on metathorax and base of abdomen dorsally mottled with bone brown. Fore wing buffy olive, the lines fine, fuscous; a double subbasal line on costa; antemedial line lunular, slightly outcurved; a faint line on discocellular; postmedial line outwardly edged with white on costa, wavy to vein 5, then crenulate, followed by a double series of black points on veins with white points between them from vein 8 to vein 3, connected by a very faint crenulate line; the veins from cell to termen black. Hind wing whitish, the inner margin buffy brown, expanding at anal angle; costal margin broadly buffy olive with a double fuscous postmedial line, and a subterminal line, preceded by a whitish shade; a terminal brown line and short dark streak on tips of veins; cilia tipped with white.

Expanse 29 mm.

Habitat.—Venezuela.

Type.—Cat. No. 33337, U.S.N.M.

HEMIPECTEROS TEFFEINA, new species

Male.—Palpi: Second joint fuscous fringed with white; third joint wood brown tipped with white. Head, collar, thorax, and abdomen above mouse gray mottled with white and benzo brown, the latter color chiefly on collar; abdomen below white. Fore wing white irrorated with mouse gray, deep mouse gray, and fuscous; some black scales from base of costa form an indistinct outbent line; antemedial and postmedial lines, also a lunule on discocellular, fine, black, all filled in with ochraceous buff, the antemedial line vertical, sinuous, the postmedial outbent along vein 8, almost vertical to vein 3, then incurved, followed by a parallel dark smoky line outangled above vein 6; terminal space suffused with drab; a fine black marginal line, wavy and incurved to vein 4, then broken and lunular; cilia mottled white and chestnut brown. Hind wing white; a narrow light drab shade at apex; a terminal fuscous lunule at anal angle, surmounted by a brown shade; the veins terminally finely brown.

Expanse 47 mm.

Habitat.—Teffe, Amazons.

Type.—Cat. No. 33338, U.S.N.M.

From the Dognin collection.

This species is allied to *H. arthemis* Schaus.

MALOCAMPA MEDOMMOCA, new species

Male.—Palpi fuscous fringed with light buffy drab. Head white, collar light ochraceous buff, the hairs posteriorly tipped with white. Thorax fuscous black, the tegulae chiefly white mottled with some dark hairs. Abdomen above ecru drab, underneath buffish. Fore wing light grayish olive; an oblique, irregular, and broken black streak from base of costa to vein 1 near antemedial line; a double subbasal dark line on costa; antemedial line, fine, double, both black on costa and inner margin, the inner line faint grayish olive, the outer line distinct, black, inangled on subcostal and median, outcurved in cell, and from above fold to vein 1; a fuscous spot at lower angle of cell; reniform outlined by black, a dark line on costa above it; postmedial line fine black, lunular on costa, outbent and sharply angled, incurved to vein 4, then inbent and incurved on each interspace to inner margin; three black spots on costa toward apex; subterminal diffuse black spots, oblique and connected from veins 8 to 6, inset from 5 to 4, outset just below 4, inset below 3, with a short black streak on inner margin at tornus. A fine marginal black line, parallel with termen from costa to vein 4, then wavy to tornus. Hind wing smoky benzo brown, the cilia white. Wings below hair brown. Fore wing with costa narrowly white and four black spots toward apex; whitish terminal streaks on interspaces. Hind wing with termen narrowly white.

Expanse 40 mm.

Habitat.—French Guiana.

Type.—Cat. No. 33339, U.S.N.M.

From the Dognin collection.

MALOCAMPA MAMMERTA, new species

Female.—Palpi black above, fringe white mottled with some black hairs. Head, collar, and thorax white mottled with some fuscous hairs, forming a transverse line on vertex and on collar. Abdomen above drab, the last two segments white irrorated with drab; underneath white. Fore wing white, the basal half with some hair brown irrorations; an ovate black line from near base of inner margin, curved to median, then outcurved to inner margin limited by the double medial line, the space inclosed deep mouse gray crossed by a dark mouse gray curved line; a fine black subbasal line; a fine double antemedial benzo brown line on costa; the double medial line fine, fuscous, outangled on costa, outcurved on cell; discocellular spot large outlined by black, filled in with whitish and buffy brown, the space before it narrowly, broadly beyond it to postmedial line suffused with wood brown, and crossed close beyond cell by an outcurved snuff brown line to just below vein 2; postmedial line fine, double, fuscous black slightly outcurved, below vein 3 slightly sinuous and inbent;

terminal space whitish irrorated with drab; subterminal line white, outcurved below costa, incurved opposite cell, expanding into a white spot between veins 3 and 4; a fine marginal black line, lunular from vein 4 to tornus; cilia white with some dark mottling. Hind wing white, somewhat suffusd with drab on inner margin and terminally along veins; cilia white. Hind wing below white; some hair brown scales medially on fringe of costa.

Expanse 42 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33340, U.S.N.M.

Near *Malocampa lunula* Dognin.

MALOCAMPA RANDAUTA, new species

Male.—Palpi fuscous black above, the cilia mottled tilleul buff and carob brown. Head, collar, and thorax mottled carob brown and white. Abdomen above benzo brown, underneath pale ochraceous buff. Fore wing: Base mottled brown and light buff limited by a double carob brown line filled in with light buff, outcurved and inangled on median; antemedial space fuscous from costa to just below median, with a few whitish scales, then to inner margin thickly irrorated with white limited by a double fuscous line filled in with cinnamon buff, outbent from costa, curved and narrower below cell to middle of inner margin, and with white points on median, fold, and vein 1; medial and outer space buffy brown irrorated with pinkish buff; reniform pinkish buff with two carob brown points; a medial line defined by absence of irrorations excurved from costa across discocellular and inbent from vein 4 to middle of inner margin crossed by fuscous streaks on veins; postmedial line fine, double, snuff brown, wavy to vein 4, then parallel to termen, with black points on veins, followed and preceded by white irrorations on veins; veins beyond mostly fuscous with some white scaling; a subterminal and a marginal snuff brown diffuse shade defined by the pale irroration from vein 7 to vein 3; a terminal carob brown line, inwardly edged from vein 3 to tornus with light ochraceous buff; cilia with dark spots at veins. Hind wing deep brownish drab; cilia naples yellow tipped with white. Fore wing below deep brownish drab; light buff spots on costa toward apex; cilia whitish buff tipped with brownish drab and divided by dark streaks at veins. Hind wing below: Base, inner margin broadly, termen narrowly and cilia light buff; outer space deep brownish drab becoming narrow at anal angle.

Expanse 40 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33341, U.S.N.M.

Allied to *M. omaita* Dognin and *M. sorex* Schaus.

MALOCAMPA BRONACHA, new species

Male.—Palpi black with a few grayish hairs in fringe. Head, collar, and thorax fuscous, the metathoracic tufts mottled with ochraceous tawny. Abdomen above cinnamon brown, underneath light buff. Fore wing fuscous suffused with hair brown; base ochraceous tawny, its outer edge indentate on median vein; antemedial line light brownish olive, finely edged with black, slightly outcurved and lunular; a round buffy olive spot on discocellular containing a few dark scales; postmedial line crenulate outwardly edged with light brownish olive on interspaces, followed by white points on veins between black points; the terminal space brownish olive, the veins black; a subterminal fuscous shade from apex to vein 4; a terminal black line preceded by light brownish olive spots on interspaces; cilia brownish olive with fuscous lines at veins. Hind wing fuscous brown, somewhat paler at base; a fine medial dark line, defined by slightly paler shading; a black and white spot at anal angle; cilia buffy brown. Fore wing below dusky drab with some whitish shading on costa to apex. Hind wing below from within cell to inner margin at anal angle light buff, otherwise dusky drab; cilia light buff.

Expanse 45 mm.

Habitat.—Avangarez, Costa Rica.

Type.—Cat. No. 33342, U.S.N.M.

Allied to *M. obscura* Schaus.

RHUDA DECEPTA, new species

Male.—Body and fore wing above as in *R. focula* Cramer. Hind wing light orange yellow, the termen fuscous black, 4 mm. in width, emitting a broad black streak toward base before inner margin; cilia light orange yellow. Fore wing below dark purplish gray, base of costal margin, inner margin to near tornus and a broad streak below cell and vein 4 to subterminal line buff yellow; costa on outer half white with black spots and fine lines; a fine subterminal whitish line preceded by velvety black spots above vein 6 to costa and followed by a similar streak above vein 7; terminal triangular yellow spots at veins 5–8, below 5 the termen yellow divided by a fine dark line between veins 4 and 2. Hind wing below pinard yellow, the marginal dark band not so broad as above, projecting very slightly well before inner margin; cilia light orange yellow which extends slightly on termen.

Expanse 55 mm.

Habitat.—Colombia.

Type.—Cat. No. 33343, U.S.N.M.

The hind wing is more like that of *R. tuisa* Schaus, the male of which is much smaller.

GISARA MEYERI, new species

Male.—Palpi: Basal joints with a lateral hazel line, a black line below it and short black fringe above, below fringed with hair brown; third joint smooth, buff white, with a small fuscous spot at tip. Head light buff, collar buffy brown behind, darker in front and transverse whitish hairs between the two. Thorax chestnut brown, the tegulae mottled drab, pale drab gray, and white; lateral white tufts on metathorax. Abdomen above benzo brown; a fuscous white tipped dorsal tuft at base; anal segment light buff with a fuscous dorsal spot, the long lateral tufts warm buff; underneath light buffish drab. Fore wing: Base drab gray crossed by a thick hair brown lunular line, limited by a double fuscous subbasal line; costal margin and cell benzo brown, the costal edge and a streak below subcostal slate color, the veins slate color with short black streaks, and white streaks on terminal space; an antemedial natal brown double line, irregular and partly broken; medial area below cell to inner margin suffused with slate gray; a natal brown medial curved line in cell, inwardly edged with cinnamon; a faint cinnamon line on discocellular; postmedial line outcurved on costa, then inbent, double, finely wavy, fuscous; a large cream white space at tornus to vein 4 with a small subterminal white spot above it, the upper edge downcurved to vein 3, inbent along 3 and irregularly curved to close to tornus, some black points on veins; subterminal dark spots toward costa; marginal black points partly irrorated with white from vein 7 to vein 4, below 4 some very small black lunules. Hind wing benzo brown, the outer margin broadly fuscous, narrowing to anal angle; cilia white suffused at base with benzo brown. Fore wing below hair brown, the costa terminally whitish with dark irrorations; terminal white patches on interspaces; marginal black points or lunules; base of cilia partly white. Hind wing below hair brown, the cell and below it to inner margin buff white; cilia white which extends on termen.

Expanse 56 mm.

Habitat.—St. Laurent, French Guiana.

Type.—Cat. No. 33344, U.S.N.M.

Type collected by Barnes and Schaus; other specimens in Dognin collection.

Near *G. procne* Schaus, differs in color, detail of markings, and the very different underside.

Named in honor of Mr. Eugene Meyer, a contributor to the Dognin fund.

GISARA BREWSTERI, new species

Male.—Similar to *G. procne* Schaus = *Sambana* Druce well figured in the Biologia. (Pl. 92, fig. 13.) Differs in having the hind wing white, the veins irrorated with benzo brown, more thickly on termen.

Expanse 57 mm.

Habitat.—San Jose, Costa Rica.

Type.—Cat. No. 33345, U.S.N.M.

Named in honor of Mr. F. F. Brewster, a subscriber to the Dognin fund.

GISARA BRAUNI, new species

Male.—Palpi: Basal joints orange cinnamon, the third wood brown above, light buff below. Head and collar orange cinnamon. Thorax medially orange cinnamon edged with white; tegulae pale drab gray mottled with light drab and light cinnamon drab; the shoulders whitish. Abdomen above fuscous, usually with a buffish dorsal line; basal dorsal tuft black mottled with bluish gray scales; anal hairs light buff and orange cinnamon. Fore wing mostly chestnut brown; costa narrowly cinnamon brown on outer half, becoming paler at apex; four light buff points on costa before apex; inner margin from below cell and obliquely below fold to postmedial line irrorated with silvery white and pale gray scales; base with some fuscous irrorations; a faint dark subbasal line; antemedial line double, fuscous and cinnamon brown, outcurved in cell, inangled below cell, vertical below fold; a postmedial lunulate, dentate, indistinct line; subterminal line double, outcurved below costa, faintly darker than ground color, then fuscous, somewhat lunular, very slightly inbent; a large terminal white space from tornus frequently suffused with olive buff on termen, its inner edge incurved from vein 3 to vein 1, above 3 extended as a subterminal curved line to vein 6, very narrow between veins 5 and 6; marginal orange cinnamon lunules, outwardly black from vein 7 to vein 3, below which are fuscous lines on interspaces. Hind wing buffy brown suffused with fuscous, faintly paler at base; cilia mottled wood brown and buff, tipped with white. Wings below dark hair brown; a fuscous medial line; interspaces darker subterminally; fore wing with costa buff on outer half also on termen; a marginal wavy fuscous line with black points, and some cinnamon brown shading on interspaces near costa; hind wing with termen and cilia light buff.

Expanse 60 mm.

Habitat.—San Antonio, Colombia.

Type.—Cat. No. 33346, U.S.N.M.

Five males from the Dognin collection.

Named in honor of Mr. F. W. Braun, of Los Angeles, a generous contributor to the Dognin fund.

GISARA METCALFI, new species

Male.—Palpi: Basal segments sayal brown with a lateral verona brown line; third joint light buff with a fine lateral fuscous line. Head and front of collar pinkish buff, collar behind pale drab gray;

lateral tufts behind eyes and base of antennal tufts sayal brown. Tegulae mottled drab gray and snuff brown with scattered cinnamon and black scales. Abdomen above hair brown; basal dorsal tufts mottled black, drab gray, and buff; anal segment and hairs, also underside of abdomen light buff. Fore wing: Costal edge avellaneous with numerous olive brown striae; a medial streak below costa, the cell and slightly beyond and below it sayal brown; base to antemedial, inner margin to above fold and on interspaces to vein 4 before outer line vinaceous buff; a double basal dark sinuous line; antemedial line double, indistinct, vertical, the outer part lunular, fuscous from cell to inner margin, followed from costa to lower angle of cell by a fine orange cinnamon sinuous line; a black point on discocellular; postmedial line faint snuff brown, outbent on costa, lunular dentate, followed by a double dark line, outcurved, faint below costa, below vein 7, the inner part lunular, orange cinnamon, partly spotted with black, the outer part of the line with larger black spots between veins 6 and 4; a silvery white space from tornus to vein 6, becoming narrower owing to terminal dark suffusions, the inner edge is incurved to vein 3, then dentate and incurved between veins 4 and 6; marginal black and white spots, reduced to fine lines below vein 3; cilia with white points at veins. Hind wing brownish fuscous, paler at base and on interspaces near cell; cilia tipped with white. Fore wing below hair brown, the costal margin and inner margin to near tornus light buff; terminal orange cinnamon shading on interspaces; the veins from cell black irrorated with white, extending on cilia with white points at veins, the termen and cilia on interspaces light buff. Hind wing below whitish buff, the costa irrorated with hair brown, the termen suffused with hair brown, not very broadly; cilia whitish with paired dark spots at veins.

Expanse, male, 66 mm.; female, 80 mm.

Habitat.—Male from Songo, Bolivia, a female from northeast Peru, and a female from Juan Vinas, Costa Rica.

Type.—Cat. No. 33347, U.S.N.M.

A male and a female from the Dognin collection.

Named in honor of Senator Jesse H. Metcalf, a generous contributor to the Dognin fund.

BORIZA IGNATIA, new species

Male.—Head, collar, and thorax isabella color; some black scales on collar behind, on dorsal edge of tegulae and on metathorax. Abdomen above chamois with black segmental bands. Fore wing above cream buff, with a very faint greenish tinge, the inner margin broadly, and outer space beyond postmedial, except on costa suffused with tawny olive and cinnamon buff irrorated with black scales, more

thickly so medially between fold and vein 1, forming a fuscous streak; a short curved basal line af black and cinnamon scales on costa; antemedial line formed by some black scales, double on costa, incurved to below cell, and outcurved across fold; reniform indicated by cinnamon buff lines; a postmedial line of black scales outcurved beyond cell to vein 2, interrupted and inbent on inner margin, followed by two faint series of black scales, barely forming lines; veins beyond cell whitish irrorated with black; some white scaling at apex preceded by a black streak between veins 7 and 8; shorter subterminal black streaks between veins 5 and 7; some terminal black points; cilia white on interspaces. Hind wing white; inner margin light buff and isabella color, the latter forming a narrow shading on outer margin.

Expanse 38 mm.

Habitat.—Blumenau, Brazil.

Type.—Cat. No. 33348, U.S.N.M.

TALMECA DABUISA, new species

Female.—Palpi bone brown fringed with light buff. Head, collar, and thorax deep olive buff. Abdomen above citrine drab, the terminal segments deep olive buff; underside citrine buff with pale segmental lines. Fore wings vinaceous buff with scattered buffy brown irrorations; a chartreuse yellow streak below cell and vein 2 to termen; a drab shade in base of cell, and a large black spot on discocellular; a hair brown streak on vein 4 to outer points, above it a faint greenish shade to termen, and similar shades on terminal interspaces; a faint basal line on costa; antemedial line punctiform, double, outbent to middle of cell, then slightly inbent; faint traces of a postmedial line, and a more remote series of points on interspaces, followed by two series of black points on veins; terminal black spots on interspaces; cilia with dark spots at veins. Hind wing drab, the cilia white.

Expanse 33 mm.

Habitat.—Corozal, Canal Zone.

Type.—Cat. No. 33349, U.S.N.M.

TALMECA AGATHOSA, new species

Male.—Palpi fuscous fringed with pale ochraceous buff. Head, collar, and thorax dark olive buff, the tegulae deep olive buff. Abdomen above chaetura drab, the last two segments and hairs at base light ochraceous buff; underneath white. Fore wing pale ochraceous buff, the inner margin suffused with dark olive buff; a similar streak below median at base, then above median to termen above vein 4; a basal and a subbasal russet vinaceous line on costa, the inner antemedial line starting from the basal line; antemedial double deeply outbent and outangled in cell, lunular below cell; a small yellowish citrine spot on discocellular; a line from costa above cell deeply out-

bent below subcostal, double, outcurved well beyond cell, lunular, russet vinaceous, followed by slight similar scaling on interspaces, then by a double series of claret brown points on veins with white points between them; termen narrowly white preceded by some dark olive buff dashes on interspaces; cilia white with claret brown points on interspaces. Hind wing dark drab, the cilia white.

Expanse 33 mm.

Habitat.—Miracema, Rio Purus, Brazil.

Type.—In Carnegie, Museum, Pittsburgh.

Paratype.—Cat. No. 33350, U.S.N.M.

CHADISRA PARAGORNA, new species

Male.—Palpi, head, collar, and thorax mottled prout's brown and white, the white hairs predominating on tegulae; a fuscous patch medially on thorax. Abdomen above prout's brown with darker segmental bands; underneath white except anal hairs. Fore wing: White scaling at base with a fine black subbasal line; costa at base and medially avellaneous, irrorated medially with white; costa beyond postmedial line white irrorated with drab also between basal and antemedial lines where the white extends into cell; basal line double, fuscous, outcurved to below cell, then outbent; inner margin to fold and from basal line to tornus suffused with light brownish olive; antemedial line double, fuscous black, lunular, incurved below cell followed below vein 2 by a white streak, these lines filled in with brownish olive and a similar shade in end of cell; a drab incurved line on discocellular outwardly edged by a dark line from costa, outangled at vein 4 with white mottling before and beyond it to postmedial from subcostal to vein 3; postmedial line fuscous black, outbent at costa and broken, crenulate, inset on vein 5, filled in with white to vein 3, inbent at vein 4 and vertical to inner margin filled in with white from vein 2 to inner margin, followed between veins 5 and 8 by velvety fuscous black streaks, by a small spot below vein 4 and a larger spot below vein 2; space beyond white to marginal line crossed by a diffuse drab shade, narrow from apex, expanding to vein 2; marginal line black, wavy, lunular, outwardly bordered with white thickly irrorated with drab to the fine fuscous terminal line; cilia white spotted with drab. Hind wing white, the outer margin broadly fuscous, extending narrowly upward at inner margin, partly cut above anal angle by a short white line; cilia white.

Expanse 35 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In the Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33351, U.S.N.M.

The species is allied to *C. fitilla* Dognin.

CHADISRA FINIANA, new species

Male.—Palpi vinaceous buff, with some natal brown scales on upper edge. Head, collar, and thorax mottled white, cinnamon drab, and benzo brown, the tegulae whitish mottled with light buff and with a few fuscous tipped hairs; sublateral white and buff hairs from metathorax. Abdomen above whitish, the fourth and fifth segments hay's brown; the basal segments with subdorsal cinnamon hairs; anal segment white with some dark scales; underneath whitish. Fore wing white with some light cinnamon drab irrorations; costal edge on basal third, except the base, brownish drab followed by similar spots to near apex; an antemedial fuscous black space from subcostal to below median vein limited by an irregular dark line, outbent and lunular below fold; a faint medial drab shade; an ill defined white lunule on discocellular; a faint drab postmedial diffuse line, followed by a more distinct, very fine outer line, fuscous black, lunular between veins 6 and 3, followed from vein 4 to costa by a broad deep brownish drab shade, limited by a white, dentate, subterminal line; below vein 3 this outer line is inset, lunular to inner margin, followed by a dark incurved line between veins 3 and 2; a drab patch at tornus; termen dark from apex to vein 4 with thick marginal black lunules; below vein 4 the termen is white with a marginal black line outcurved at end of veins 3 and 2. Hind wing white, the outer margin fuscous, and a short curved black line about it at anal angle.

Expanse 34 mm.

Habitat.—Villavicencio, Colombia.

Type.—Cat. No. 33352, U.S.N.M.

Two males from the Dognin collection.

CHADISRA ULRICA, new species

Male.—Palpi chestnut brown above, below whitish with benzo brown irrorations. Head mottled drab and whitish, some fuscous hairs on tufts at antennae. Collar mostly fuscous; thorax mostly drab and white. Abdomen above drab with some white scaling and whitish segmental lines, underneath whitish buff. Fore wing drab; dark mouse gray suffusions in cell near base and below subcostal to postmedial line; benzo brown spots and lines on costa; subbasal and antemedial fuscous lines below cell, the antemedial outbent; some light buff hairs at base of inner margin; no distinct mark on discocellular; a faint cinnamon drab postmedial line outcurved around cell, somewhat dentate, at submedian fold downbent forming two fuscous lunules to inner margin; a more remote fine fuscous black line from vein 7, slightly outangled at vein 6, vertical to vein 4, and lunular inbent to inner margin, followed above vein 2 by a fuscous black streak, above vein 3 a shorter similar streak outset, and small

spots above other veins to vein 8, all followed by a faint whitish subterminal wavy shade; a fine fuscous black lunular marginal line. Hind wing white the costal and outer margin hair brown. Fore wing below largely white with brownish suffusions on costal half. Hind wing below white; a short benzo brown shade from costa close to apex.

Expanse 38 mm.

Habitat.—Teffe, Amazons.

Type.—Cat. No. 33353, U.S.N.M.

From the Dognin collection.

CHADISRA EZRANA, new species

Female.—Palpi chestnut, the fringe partly tipped with white. Head, collar, and thorax deep brownish drab mottled with white. Abdomen above drab with paler segmental lines; underneath tilleul buff. Fore wing buffy brown; costa to postmedial line, inner margin to fold, and terminal area irrorated with white; some white scaling at base; a short outbent black line from base below cell; a short fuscous streak in cell near base, and a longer streak below cell to antemedial, this line faintly darker, double, filled in with white, interrupted in cell, lunular below fold; a faint darker line from costa to discocellular on which are two small black spots; postmedial line darker, double, slightly outcurved, well beyond cell; a subterminal hair brown shade, outwardly edged with whitish, below vein 4 clear white, expanding from vein 3 to tornus; white spots at termen on interspaces, leaving a narrow dark terminal line; cilia white with brown spots at veins. Hind wing whitish suffused with avellaneous, the veins dark; outer margin broadly dark drab, fuscous and excurved above at anal angle, with white above it divided by an excurved white line. Hind wing below with the costa dark drab to near base.

Expanse 41 mm.

Habitat.—Nova Olinda, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33354, U.S.N.M.

Allied to *Chadisra lautina* Dognin.

CHADISRA CELSA, new species

Male.—Palpi, head, collar, and mesothorax mottled white and buffy brown, the palpi buffy brown above. Metathorax mottled white and fuscous. Abdomen above mouse gray, some cinnamon hairs at base; anal segment and hairs mostly white; underneath white irrorated with buffy brown, very thickly on basal half. Fore wing white largely irrorated with buffy brown, less so on terminal area, some long hairy scales near base in and below cell; faint, fine, dark basal and subbasal lines; antemedial line fine, approximated to medial, thicker on costa

with some fuscous scales, the antemedial defined on inner side by clearer white, followed by a few black scales on median vein and fold, the medial line somewhat outbent, not reaching inner margin; a clear white spot on discocellular; postmedial line fine, fuscous black, lunular, at vein 2 slightly inset and vertical with smaller lunules, followed from costa to inner margin by a broad wood brown shade with small fuscous spots on outer edge above and below submedian fold; subterminal diffuse brownish shading; a marginal black line, straight from below apex to vein 3, then slightly lunular wavy. Hind wing white, the tips of veins and termen narrowly wood brown.

Expanse 36 mm.

Habitat.—Songo, Bolivia.

Type.—Cat. No. 33355, U.S.N.M.

A male and female from the Dognin collection.

This species is allied to *C. tenuis* Schaus and *C. lauta* Schaus.

CHADISRA EMETERIA, new species

Male.—Palpi fuscous black above, underneath white irrorated with fuscous. ons brownish drab thickly mottled with white hairs; a fuscous black line between antennae; vertex and collar cinnamon brown, the latter edged laterally and behind with fuscous tipped with white; thorax drab, the tegulae white irrorated with fuscous. Abdomen above drab, the anal segment and hairs mottled benzo brown and white; underneath white. Fore wing silvery white thinly irrorated with drab, the lines fuscous; a broken basal line; subbasal line double, inbent on costa, outset in cell, diverging below cell, the inner part incurved, crossing a buff yellow spot below fold, the outer part, outcurved approximating the antemedial line; antemedial line double, finely wavy, slightly outcurved, filled in with benzo brown from cell to inner margin, outwardly edged with buff yellow above fold, and below fold to inner margin by two maize yellow lunules; a buff yellow crescent at end of cell, partly edged with benzo brown, part of a line from costa which approximates the antemedial line at fold and edges the two yellow lunules, crossing buff yellow spots below veins 3 and 2; postmedial line indentate on costa, outangled at vein 6, double from vein 6 to vein 3, filled in with buff yellow above veins 5 and 4; a narrow space before the postmedial on inner margin benzo brown, also the tornal area; from below vein 2 the postmedial is outwardly bordered with white, partly suffused with maize yellow; a subterminal series of black streaks and spots on interspaces very small between veins 4 and 5; a marginal wavy black line; terminal black points at veins; cilia white with paired drab spots at veins. Hind wing white, the outer margin broadly benzo brown; some dark scaling near inner margin above anal angle; a partly double small angled black line at anal angle.

Expanse 36 mm.

Habitat.—Nova Olinda, Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33356, U.S.N.M.

Allied to *Chadisra extranea* Schaus, which is darker and has none of the buff yellow markings on fore wing.

MERAGISA SALVINA, new species

Male.—Palpi black fringed with white and buffy brown hairs. Head, collar, and front of thorax mottled white and buff brown, the thorax otherwise and tegulae mostly white; from metathorax laterally and behind light buff tufts. Abdomen above drab with faint white segmental lines, the base with cinnamon scaling, the anal segments white with a few dark scales; underneath light buff. Fore wing white irrorated with wood brown, the costal edge light buff; a subbasal massicot yellow line, inbent outwardly edged with army brown scales; antemedial and outer lines double, buffy brown filled in with massicot yellow, the former outset in cell, faintly outbent below cell; a dark medial line from costa to median vein, its outer edge with a massicot yellow line on discocellular; postmedial line very fine wood brown, lunular, incurved opposite cell and below vein 3; outer line lunular, incurved from costa, outset between veins 4 and 3, then again incurved; fuscous marginal semicurved lines, and fuscous terminal spots, forming a line toward apex. Hind wing drab, the inner margin cream buff; cilia white.

Expanse 54 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33357, U.S.N.M.

Allied to *M. pallescens* Schaus and *M. cloacina* Dognin, but not so white.

MERAGISA VISTARA, new species

Male.—Palpi black above, not reaching tips; fringe white with a few dark hairs. Head, collar, and thorax mottled with white and fuscous hairs; a transverse fuscous line on collar; metathorax with warm buff hairs. Abdomen above cinnamon on two basal segments, then wood brown overlaid with deep olive buff hairs, the last two segments white irrorated with black; underneath warm buff. Fore wing silvery white irrorated with buffy brown, the subcostal veins from cell, and vein 1 tinged with olive buff; the antemedial and outer lines black, double, filled in with deep olive buff, also the subbasal line on costa, subbasal line double on costa, inbent, single, excurved and outbent below cell; antemedial line inbent on costa, outset in cell, lunular and outbent below cell to inner margin; a white spot on discocellular with a black and warm buff line, above it on costa a faint dark outbent line; postmedial line very fine, lunular dentate,

dark olive buff, outcurved from costa, slightly incurved from below vein 3; outer line double and inbent from costa to vein 3, then single; oblique, curved, black marginal streaks on interspaces; terminal black spots. Hind wing hair brown, the inner margin broadly warm buff; a postmedial fuscous line, outangled on inner margin; traces of a subterminal line, well marked at anal angle; cilia white. Fore wing below deep quaker drab, the margins maize yellow. Hind wing below maize yellow, suffused below costa and subterminally with deep quaker drab.

Expanse 63 mm.

Habitat.—Buena Vista, Colombia.

Type.—Cat. No. 33358, U.S.N.M.

MERAGISA SIMEONA, new species

Male.—Antenna with the fascicles more developed than in any other species of the genus. Palpi chestnut brown fringed with drab gray. Head and collar mottled white and chestnut brown. Thorax and tegulae pale smoky gray with a few drab hairs. Abdomen above hair brown; some cinnamon scaling at base; anal segment white irrorated with hair brown; underside light buff. Fore wing white; base just below cell and middle area irrorated with wood brown; some black scales form an indistinct subbasal line; an antemedial chestnut brown line, double, thick, finely dentate, outbent to median vein, then fainter, lunular, vertical to vein 1 and outbent on inner margin; inner margin from near base to outer line broadly suffused with light cinnamon drab; discocellular with a fine fuscous line edged with white; postmedial line extremely faint, light cinnamon drab, outcurved around cell; outer line fuscous lunular, inbent from costa to vein 4 followed by orange cinnamon spots, slightly outset below vein 4 and again inbent with only faint traces of orange cinnamon beyond; a marginal deeply curved black line, partly cut by veins on termen; cilia white. Hind wing drab, the inner margin light buff; cilia white.

Expanse 45 mm.

Habitat.—Monte Tolima, Quindiu, Colombia.

Type.—Cat. No. 33359, U.S.N.M.

Two males and a female from the Dognin collection.

MERAGISA EUTHYMIA, new species

Male.—Palpi fuscous with a few white hairs in fringe. Head, collar, and thorax mottled pallid neutral gray and army brown, the latter forming a conspicuous dorsal patch on collar and front of thorax; light buff lateral tufts from metathorax. Abdomen above suffused with cinnamon on basal segment, the following segments hair brown, the last two segments white irrorated with hair brown; underside light buff. Fore wing white rather thickly irrorated with drab; costa grayish olive at base; a wavy subbasal fuscous line with some

warm buff scales on costa and just below cell. Antemedial line double, benzo brown, inangled on subcostal, below cell fainter slightly outbent to inner margin; a white and fine dark line on discocellular, and a small outbent line above it on costa; a double outbent postmedial line on costa, then inbent and hardly traceable; outer line double, hair brown, inbent forming a single lunule from vein 6 to vein 4, inset at vein 3 and excurved to inner margin; marginal line fuscous, broken, well edged on inner side with white; a terminal punctiform line; cilia white. Hind wing dark drab; inner margin broadly warm buff crossed by a dark curved line above anal angle; cilia white.

Expanse 51 mm.

Habitat.—Santo Domingo, Peru.

Type.—Cat. No. 33360, U.S.N.M.

A male from the Dognin collection.

Differs in color and its white cilia from the allied species *M. submarginata* Schaus and *M. innoxia* Schaus.

MERAGISA MOCHOSEMA, new species

Male.—Palpi fuscous, the fringe terminally mottled light grayish olive and cinnamon drab. Head, collar, and tegulae dorsally mottled light grayish olive and benzo brown, the tegulae otherwise mottled olive buff and white. Abdomen above hair brown, the base pinkish cinnamon overlaid with light buff hairs; terminal segment irrorated with white and fuscous; underneath warm buff. Fore wing deep olive buff irrorated with fuscous scales, the markings chiefly fuscous; edge of costa at base warm buff; a basal point below cell; a double subbasal line, consisting below cell of a few fuscous scales, followed by a patch on costa; antemedial line double, vertical, interrupted by veins, closely followed by a double medial line, the outer part macular to fold, then outbent lunular; a faint white line on discocellular with a few black scales on outer edge; postmedial line fine, dusky, faintly outcurved, and incurved below cell; outer line from costa near apex, double, lunular, somewhat incurved to vein 3, then more so to inner margin, filled in with dark olive buff from vein 6 to costa, and between veins 2 and 3; a faint irregular subterminal shade; a marginal natal brown line, inwardly edged with white, vertical from costa to vein 6, inset and vertical wavy to vein 2, again inset forming oblique lines; termen mottled with whitish; a terminal natal brown line; cilia tipped with white. Hind wing army brown; a double dark curved line above anal angle, defined by whitish; a darker terminal line; cilia white.

Expanse 41 mm.

Habitat.—Teffe, Amazons.

Type.—Cat. No. 33361, U.S.N.M.

Two males from the Dognin collection.

MERAGISA POLYCARPA, new species

Male.—Palpi fuscous above edged laterally with army brown, the fringe white. Frons mottled white, fuscous and cinnamon. Vertex white and fuscous with an angled fuscous line in front. Collar white and fuscous crossed by a fuscous line and edged with fuscous behind. Thorax white and fuscous. Abdomen above light drab; underneath buff white. Fore wing whitish thickly irrorated and mottled with buffy brown producing a darker shade toward apex; a fine basal black line from costa to cell; a double fuscous subbasal line, outbent on costa, inbent in cell, slightly outcurved below cell, followed from fold to vein 1 by a dusky neutral gray spot; antemedial line double benzo brown, outcurved, lunular; a short black line on discocellular; postmedial line, double, benzo brown, lunular dentate, the inner part fuscous between veins 5 and 2, with long projecting points on veins, almost reaching the marginal line, this latter consisting of small black spots toward apex, below vein 6 of small black lunules; terminal black points on interspaces, and short lines on tips of veins; cilia mottled white and cinnamon drab. Hind wing buffish drab, broadly benzo brown on outer margin; cilia white.

Female.—Fore wing with fewer dark mottlings, but the dark shade beyond cell toward apex, partly fuscous, the postmedial line between veins 2 and 3 heavily marked.

Expanse, male, 34 mm.; female, 35 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33362, U.S.N.M.

Closely allied to *M. arenosa* Schaus.

DUGONIA, new genus

Female.—Antenna serrate with short fascicles of hairs at base, then ciliate to middle. Palpi slightly upturned, long, the second joint thickly scaled, the third smooth. Legs smooth, the mid tibia with a long and a short terminal spur, the hind tibia with two pairs of long spurs, the outer terminal spur short. Fore wing long and rather narrow, the termen somewhat crenulate; vein 2 from beyond middle of cell; 3 and 4 from lower angle; 5 from middle of discocellular; areole short originating at end of cell; 6 from upper angle; 7, 8 and 9, 10 from end of areole; 11 free. Hind wing: Costa straight; apex rounded; termen somewhat obtuse below vein 2 to anal angle; cell half the length of wing; vein 2 well before lower angle; 4 and 5 from lower angle; 6 and 7 from upper angle; 8 diverging from cell before middle.

Genotype.—*Dugonia eliera*, new species.

DUGONIA ELIERA, new species

Female.—Palpi mikado brown irrorated with white. Head and neck mottled cinnamon and white. Collar and thorax mikado brown. Abdomen above fuscous, the anal hairs white; underneath white

irrorated with avellaneous. Fore wing chestnut brown; a postmedial and an outer double series of small fuscous black spots; an oblique sayal brown shade from cell to apex; orange cinnamon mottlings on inner margin, expanding at tornus to between veins 2 and 3, where it is inwardly preceded by a trigonate white spot and a white streak above it to termen; some orange cinnamon below and above vein 4 at termen; traces of subterminal white lunules from vein 5 to vein 1. Hind wing verona brown; orange cinnamon and white mottling along inner margin, on which are verona brown spots. Cilia on both wings partly white. Wings below dresden brown.

Expanse 30 mm.

Habitat.—French Guiana.

Type.—Cat. No. 33363, U.S.N.M.

From the Dognin collection.

EUXOGA AMATURA, new species

Male.—Palpi white mottled with buffy brown. Head, collar, and thorax white irrorated with tawny, densely so on edge of collar, and on edge of tegulae. Abdomen above cinnamon drab, the base, anal hairs, and underside white. Fore wing: Base, cell and medial area pallid mouse gray irrorated with fuscous which form a double subbasal sinuous line; an antemedial and medial line, diverging below cell, with a white spot below them above vein 1; a brownish olive line edged with white on discocellular with projecting lines at each end on basal side; a fine, dark, dentate postmedial line, followed by a pale mouse gray even line, both outcurved around cell to vein 2, then excurved to vein 1; the pale gray line followed by a double series of black points on veins with white points between them, these points followed by a bister shade diverging from vein 6 to costa and from vein 2 to tornus; a large pallid mouse gray spot from vein 7 to costa close to apex; the terminal area broadly and thickly irrorated with dark grayish brown crossed by a lunular pallid mouse gray shade, and beyond by a fine similarly colored line sinuous to vein 3 at termen, inset and oblique below veins 3 and 2; cilia natal brown. Hind wing fuscous, paler at base; a white streak close to inner margin, expanding toward anal angle with a few natal brown scales; cilia white from apex to below vein 2, then fuscous. Hind wing below fuscous with a large white space below cell from base not reaching termen.

Expanse 30 mm.

Habitat.—Amatura, Amazons.

Type.—Cat. No. 33364, U.S.N.M.

A male from the Dognin collection.

RIFARGIA HAITIA, new species

Female.—Head, collar, and thorax white, mottled with buffy brown on vertex and collar, with black and fuscous on tegulae. Abdomen silvery mouse gray mottled with light brownish olive, and with

brownish olive segmental lines; underneath white. Fore wing pale mouse gray, the costa white irrorated with army brown; base below cell white irrorated with black; a subbasal black line inangled below cell; antemedial line fine, double, brown, inbent on costa, black and slightly outcurved to inner margin; a large crescent on discocellular, outlined in black; a fine and very faint double postmedial line slightly darker than ground color; a subterminal sinuous drab shade double from costa to vein 4; a marginal black line parallel with termen, slightly lunular below vein 3 to tornus; termen and cilia white irrorated with black. Hind wing white; a narrow terminal hair brown shade, its edge outwardly wavy; cilia white.

Expanse 35 mm.

Habitat.—Port au Prince, Haiti.

Type.—Cat. No. 33365, U.S.N.M.

Somewhat like *R. bichorda* Hampson from the Bahamas.

RIFARGIA DEMISSA BRIOCA, new form

Female.—Differs from the typical form in having the postmedial line of fore wing followed by a continuous well-defined black fascia, its outer edge partly dentate.

Expanse 45 mm.

Habitat.—British Guiana.

Type.—Cat. No. 33366, U.S.N.M.

RIFARGIA AUSCHARIA, new species

Female.—Palpi fuscous fringed with white and a few buffy brown hairs. Head, collar, and thorax white thickly mottled with fuscous and cinnamon brown hairs on vertex, collar, and tegulae. Abdomen above mottled white and benzo brown; anal hairs mostly white; underneath white. Fore wing white irrorated with black and hair brown, also with grayish olive on postmedial area; lines very faint except on costa, hair brown; antemedial line double, inbent on costa, outcurved across cell to fold, then inbent; a light buff incurved line on discocellular, inwardly edged with fuscous; postmedial line double, outcurved around cell, with fuscous points or short streaks on veins, followed by two more series of fuscous points on veins; a marginal fuscous line, mostly punctiform inangled on vein 5; cilia white with benzo brown spots at veins and a few dark hairs otherwise. Hind wing white suffused with smoky mouse gray, darker on veins and termen; cilia white.

Expanse 42 mm.

Habitat.—Valera, Venezuela.

Type.—Cat. No. 33367, U.S.N.M.

Easily distinguished by the punctiform lines on outer half of fore wing.

RIFARGIA POSSIDA, new species

Male.—Palpi: First and second joints fuscous fringed with white; third joint white with a brown spot. Frons white; vertex mottled benzo brown and white. Collar benzo brown with some white hairs, laterally white. Thorax white with a few black hairs, the tegulae in front dorsally mottled with benzo brown. Abdomen above white suffused with drab, the anal hairs mottled with drab hairs; underneath white. Fore wing from base to discocellular and tornus white with a few scattered black scales; a subbasal and a double antemedial lunular line, formed by thin black scaling, and between the lines on costa to within cell a quadrate brownish drab spot irrorated with white and edged with fuscous black; a fuscous medial line on costa joining the black line on discocellular, the latter outwardly upcurved to vein 8, and downbent to vein 5 at postmedial; outer space beyond discocellular brownish drab, irrorated with white on termen, more broadly below vein 4; postmedial line double, lunular, fuscous, above vein 6 diverging; a marginal lunular fuscous line; cilia white mottled with drab gray; and with dark spots at veins. Hind wing white; a small dark spot at anal angle.

Expanse 39 mm.

Habitat.—Porto Velho, Amazons.

Type.—Cat. No. 33368, U.S.N.M.

RIFARGIA EVERITI, new species

Male.—Palpi drab with a chestnut brown line above and a thick black lateral line. Head and collar fuscous black; tegulae sayal brown; thorax mottled avellaneous, light drab, and buffy brown. Abdomen above hair brown basally suffused with orange cinnamon in the female; underneath tilleul buff. Fore wing whitish irrorated with buffy brown and ochraceous tawny, less so on anterior third of wing; an irregular black patch at base of costa entering cell; a double antemedial vertical black line connected with basal patch by a black line below cell, and preceded in cell by a whitish space; reniform vertical, narrow, somewhat oval and whitish defined by a fine fuscous line edged narrowly with whitish; postmedial line thick, black, very outbent to vein 8, then fine, vertical, somewhat sinuous to vein 3, incurved to vein 2 in a line with discocellular and outbent to inner margin, followed from below vein 4 to termen and tornus by a dark vinaceous brown shade; from postmedial below vein 8 a thick black streak upbent to costa at marginal line; marginal line black, almost straight to vein 3, then lunular to tornus. Hind wing fuscous; a faint postmedial sinuous line, downbent near inner margin to anal angle where it is well defined in black and white.

Expanse, male, 65 mm.; female, 80 mm.

Habitat.—French Guiana.

Type.—Cat. No. 33369, U.S.N.M.

From the Dognin collection.

Named in honor of Mr. Everit Macy, one of the two largest subscribers to the Dognin fund.

AFILIA VENADIA, new species

Male.—Palpi, head, collar, and thorax mottled fuscous, hair brown and white. Abdomen above cinnamon, suffused with orange cinnamon at base. Fore wing: Base, costal margin, and medial area whitish with a few dark irrorations; antemedial and terminal area light cinnamon drab; lines fine, mostly fuscous; basal line outcurved; antemedial line slightly outcurved, inangled on median and vein 1, preceded by a faint parallel cinnamon-drab line; a line on discocellular; postmedial line double, cinnamon drab, the inner part with fuscous scaling on costa and below vein 4, outangled on vein 6, incurved opposite cell, lunular below vein 3; subterminal line broken by veins, dentate or lunular on interspaces; a marginal line, inset and irregular below vein 4; on medial area the white below cell is partly devoid of dark scaling and forms a large spot. Hind wing white suffused with light buff; cilia white.

Expanse, male, 28 mm.; female, 30–39 mm.

Habitat.—Venadio, Mexico.

Type.—Cat. No. 33370, U.S.N.M.

A long series in the United States National Museum.

AFILIA PURULHA, new species

Male.—Mottling of head and thorax hair brown and white. Abdomen above cinnamon drab. Fore wing more uniformly gray than in *A. venadia;* subbasal line outcurved black, partly double; antemedial line, almost medial, double, black, curved on costa, then well inbent, with a black line projecting basad to subbasal line; postmedial line drab, macular, preceded by a fine, indistinct, disconnected drab line; a black line on discocellular; subterminal line hair brown, macular, inbent from costa to vein 4, then sinuous; marginal line fuscous, sinuous below vein 4. Hind wing and cilia pure white.

Expanse 38 mm.

Habitat.—Purulha, Guatemala.

Type.—Cat. No. 33371, U.S.N.M.

Two males collected by Barnes and Schaus.

LUSURA TURNINA, new species

Male.—Palpi above cinnamon brown, the long fringe on terminal half benzo brown with a few white hairs. Head, collar, and thorax cinnamon brown mottled with white hairs. Abdomen above russet with dark transverse bands. Fore wing: Costa to near middle

prout's brown, the lines defined by white scaling between them; basal area mostly cinnamon brown crossed by a basal, a double subbasal, and double antemedial prout's brown lines, all somewhat macular, being cut by the veins; a fuscous streak on submedian fold to postmedial; medial and outer area mostly sayal brown, with white irrorations on medial space, also before and beyond postmedial line; discocellular spot cinnamon brown edged with white scales; postmedial line double, dentate, lunular, cinnamon brown, incurved below vein 3; subterminal shade sayal brown, diffuse, with black streaks on veins, followed by an avellaneous spot on costa; a marginal wavy black line. Hind wing benzo brown, the basal half suffused with grayish olive. Fore wing below fuscous, the costa and an apical spot whitish buff. Hind wing below hair brown, the costa and basal half suffused with whitish.

Expanse 39 mm.

Habitat.—French Guiana.

Type.—Cat. No. 33372, U.S.N.M.

From the Dognin collection.

LOBEZA PETROPOLIA, new species

Female.—Palpi black above, the base and laterally wood brown; fringe with a few black hairs. Head, collar, and thorax white mottled with black hairs; a black line on frons close to eyes; metathorax with some cinnamon medial scaling outwardly edged by a short black line. Abdomen above white with broad hair brown bands interrupted dorsally; a dorsal white tuft at base, the last segment white irrorated with black. Fore wing white irrorated with black, more densely subterminally; antemedial line fine consisting of black and warm buff scales, outcurved to below median then forming two oblique curves to beyond middle of inner margin; a small, clear, white spot at lower angle of cell; postmedial line fine consisting of black and warm buff scales, slightly lunular, incurved opposite cell, well outcurved between veins 4 and 3, then incurved followed by a broad shade formed by black and warm buff scales; termen narrowly white; a terminal black crenulate line expanding at veins; large black spots on cilia on interspaces. Hind wing light drab; a darker terminal line; costal margin broadly white; cilia white. Hind wing below mostly white; a broad medial hair brown line, and similar dusting on interspaces before termen.

Expanse 85 mm.

Habitat.—Petropolis, Brazil.

Type.—Cat. No. 33373, U.S.N.M.

Somewhat like the female of *L. huacamaya* Schaus.

LOBEZA GILBERTA, new species

Male.—Palpi cinnamon brown at base, fuscous above, otherwise white. Head and collar white mottled with deep mouse gray and sayal brown; thorax grayish white with a few dark hairs. Abdomen above cinnamon brown with dorsal white spots, and fine dark segmental lines, the last segment and tips of anal hairs white, the former irrorated with fuscous; underneath white banded with mouse gray. Fore wing white irrorated with fuscous, very slightly on medial area; antemedial line fine, dark, with a few warm buff scales, inset below median then outbent to middle of inner margin; discocellular mark clear white with a dark point at lower angle of cell; postmedial line fine, formed by chestnut brown scales, lunular slightly incurved opposite cell and below vein 3 followed by a parallel line of brownish dusting; terminal line fine, expanding at veins; no spots at cilia on interspaces, only a few dark scales at veins. Hind wing white; a faint dark medial line, punctiform on veins; a slight dark postmedial shade.

The female is more thickly irrorated on fore wing with dark scales, the lines more pronounced; dark spots on cilia on interspaces; hind wing largely suffused with drab on terminal half.

Expanse, male, 58 mm.; female, 70 mm.

Habitat.—St. Jean, Maroni River, French Guiana.

Type.—Cat. No. 33374, U.S.N.M.

Three males and two females in the United States National Museum.

Belongs to the *L. aglone* group.

LOBEZA HUACAMAYA, new species

Male.—Palpi carob brown fringed with white. Frons white, laterally carob brown. Vertex and tegulae white with a few black scales. Collar mottled white and fuscous, the anterior edge carob brown. Metathorax mottled black, orange buff and white. Abdomen above white with mouse gray segmental lines; underside light buff. Fore wing white thinly irrorated with black scales; antemedial line fine orange buff with black irrorations, irregularly outcurved to below cell, then out bent to the medial line near inner margin; a small annulus on discocellular closely followed by the fine vertical medial shade which is dentate on its outer edge. Postmedial line fuscous black, consisting of lunules, outbent on costa, then slightly inbent to vein 3 and vertical preceded by a clearer white space, and followed by a parallel line mottled with ochraceous orange, broadly irrorated beyond with fuscous and ochraceous orange scales to the faint whitish subterminal shade; a marginal black lunular line cut at tips of veins; cilia white with small fuscous spots on interspaces. Hind wing white

suffused with hair brown in cell and interspaces; veins and a medial line hair brown; inner margin buffish. Wings below white.

Expanse, male, 60 mm.; female, 83 mm.

Habitat.—Rio Huacamaya, Peru.

Type.—Cat. No. 33375, U.S.N.M.

LOBEZA MARONIA, new species

Male.—Palpi carob brown fringed with white. Head, collar, and thorax white, the collar with some wood brown mottling, the tegulae with a few mouse gray hairs. Abdomen above brownish drab with white segmental lines and white hairs dorsally; underneath white. Fore wing white thinly irrorated with black and drab scales, leaving a clear white space before the postmedial line; antemedial line fine, double on costa, consisting of a few black and ochraceous orange scales, inset below median and outbent to medial line on inner margin, the latter very faint, outwardly dentate with ochraceous orange scaling from fold to inner margin; a fuscous line on discocellular; postmedial line double, lunular, the inner part fuscous, the outer part paler, outbent on costa, incurved from vein 8 to vein 3, a deeper curve between veins 3 and 2, then vertical, lunular dentate; a broad subterminal diffuse white space, due to absence of irrorations; a fine marginal lunular dark line; cilia white; small spots on interspaces. Hind wing light drab brown, the costal margin white; cilia white. Wings below white; a fine indistinct medial line on hind wing. The female has the underside of wings light drab.

Expanse, male, 68 mm.; female, 85 mm.

Habitat.—St. Jean Maroni, French Guiana.

Type.—Cat. No. 33376, U.S.N.M.

Two males and three females in the United States National Museum.

The male type from the Dognin collection.

LOBEZA VENICA, new species

Male.—Palpi black, the fringe white with a few black hairs; a lateral brownish line on second joint. Frons white; vertex white and gray. Collar and thorax mottled white, with underlying wood brown and light buff hairs. Abdomen above dull snuff brown with light pinkish cinnamon segmental lines; anal hairs and underside whitish. Fore wing white, thinly irrorated with fuscous; antemedial line double, fuscous, outbent to median, inset below, outbent to vein 1 and curved on inner margin; discocellular white; medial line faint, outwardly prolonged on veins; postmedial line double on costa and macular, black, outangled on vein 7, lunular and deeply incurved to vein 3, then vertical, deeply dentate to inner margin, followed by a much less distinct parallel line of fuscous and ochraceous scales; terminal line fine, lunular, expanding at veins; cilia white with dark

spots on interspaces. Hind wing white suffused with hair brown; a dark medial line; inner margin with avellaneous scaling. Wings below white, the fore wing with a hair brown vertical, dentate, postmedial line.

Expanse 58 mm.

Habitat.—Merida, Venezuela.

Type.—Cat. No. 33377, U.S.N.M.

LOBEZA RHENIA, new species

Male.—Palpi pecan brown above, otherwise white. Head, collar, and thorax white with scattered fuscous hairs. Abdomen above white at base and terminally, the latter with some cinnamon brown hairs, the second to sixth segments cinnamon with whitish segmental lines; underneath white. Fore wing white thinly irrorated with fuscous scales; antemedial line faint in male, more pronounced in female, double on costa, almost vertical and somewhat punctiform to below cell, then sinuous, outbent to the faint medial line; discocellular mark white; postmedial line lunular dentate, double in female, incurved opposite cell, vertical between veins 4 and 3, then very slightly incurved; the male without terminal line, only some fuscous scales on interspaces, the female with a fine dark terminal line projecting on cilia. Hind wing white.

Expanse, male, 62 mm.; female, 84 mm.

Habitat.—Muzo, Medina, Colombia.

Type.—Cat. No. 33378, U.S.N.M.

Belongs to the *L. aglone* group, and the only described allied species with clear white hind wings.

From the Dognin collection.

LOBEZA MEDINA, new species

Male.—Palpi dusky brown, the fringe tipped with white. Head, collar, and tegulae white mottled with fuscous so they appear grayish; thorax overlaid with bone brown hairs from below tegulae. Metathorax with white tufts dorsally edged with bone brown and some ochraceous orange scales. Abdomen white with subdorsal snuff brown spots, meeting dorsally at base. Fore wing white; base to antemedial irrorated with fuscous scales, except at base of inner margin; antemedial line fuscous, macular from costa to below cell, outcurved, then outbent mottled with light orange yellow scales; medial area between lines with very few irrorations, a few forming an indistinct line from costa across discocellular to antemedial line at fold; postmedial line vertical consisting of small fuscous spots; terminal area irrorated with olive brown more densely near the postmedial series of spots; a fine terminal line; cilia white. Hind wing white suffused with light buff on base and inner margin; a medial hair brown line from costa to near anal angle.

Expanse 67 mm.

Habitat.—Medina, Colombia.

Type.—Cat. No. 33379, U.S.N.M.

From the Dognin collection.

LOBEZA ARNOULA, new species

Male.—Palpi carob brown above, kaiser brown laterally, the fringe white; throat and sides of frons carob brown, the frons otherwise and thorax mottled white and hazel; the collar carob brown with some white tipped hairs behind. Abdomen above hazel banded with carob brown; anal segment mottled white and hazel; underneath whitish. Fore wing white irrorated with chestnut brown; a subbasal spot on costa; lines chestnut brown with a few orange buff scales; antemedial line slightly outbent from costa to median, then sinuous and outbent to middle of inner margin; a discocellular fuscous point at lower angle of cell, and a faint streak above it with some white scales on inner side; postmedial line outangled at vein 7, incurved lunular to vein 4, outcurved to below 3, then outbent to vein 1, angled and inbent, closely followed by a faint paler line; a subterminal broad white shade, incurved opposite cell; an interrupted fine terminal line expanding slightly above and below veins; cilia white with brown lines or spots on interspaces. Hind wing cinnamon drab with a slightly darker medial line; cilia white suffused with brown at anal angle.

Expanse 65 mm.

Habitat.—Carabaya, Peru.

Type.—Cat. No. 33380, U.S.N.M.

LOBEZA GENEBRARDA, new species

Male.—Palpi black above, laterally cinnamon brown, the fringe white with a few dark scales. Frons with white hairs predominant; vertex mottled carob brown and white. Collar carob brown tipped with white behind. Thorax and tegulae mottled white with a few dark hairs. Abdomen above hair brown partly mottled with orange cinnamon; basal segments with whitish lines; last two segments mottled white with a few brown scales; underside light buff with slight dark segmental lines. Fore wing white irrorated with chestnut brown, the lines formed by closer set scales mottled fuscous, chestnut brown, and orange buff; antemedial line outangled on subcoatal and median incurved from median to fold, then outbent to middle of inner margin; a fuscous spot on discocellular with a chestnut brown point above it; a faint darker shade close beyond cell, vertical from costa to vein 4 then slightly inbent; postmedial line double, the inner part more heavily marked, vertical on costa, faintly incurved from veins 6–4, outangled at vein 3, then vertical to inner margin; traces of a subterminal whitish shade; a marginal lunular fuscous line, thickened at tips of veins; cilia white with small dusky spots on interspaces.

Hind wing; base to beyond dark medial line whitish with light buffish and gray suffusions, the veins crossing it hair brown; termen broadly dark cinnamon drab; cilia white.

Expanse 60 mm.

Habitat.—Rio Huacamaya, Peru.

Type.—Cat. No. 33381, U.S.N.M.

LOBEZA ABDJESA, new species

Male.—Palpi fuscous, the fringe and frons army brown with some white hairs; vertex and collar deep mouse gray, the tegulae the same with white mottling, the thorax mottled with sayal brown. Abdomen above fuscous with sayal brown segmental lines and white hairs at base and dorsally, the last two segments mottled white and sayal brown; underneath drab with light buff segmental lines. Fore wing white irrorated with chestnut brown, the lines fuscous mixed with orange buff scales; antemedial line vertical from costa, incurved slightly in cell, more deeply incurved below median and outbent to a faint medial shade which suffuses with discocellular on which is a short black line; postmedial line vertical, slightly incurved between veins 3 and 2; an irregular subterminal narrow white shade, only slightly irrorated with dark scales; a marginal chestnut line with projecting spots on termen at veins; cilia white with a few dark scales on interspaces. Hind wing hair brown, the cilia white. Fore wing below largely suffused with hair brown. Hind wing below grayish with a dark medial line.

Expanse 60 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33382, U.S.N.M.

LOBEZA GUNTHIERNA, new species

Male.—Palpi; head, collar, and thorax mottled white and cinnamon brown. Abdomen above walnut brown, overlaid partly with pale mouse gray hairs, the anal segment white mottled with cinnamon brown; underneath buffish white. Fore wing white irrorated with walnut brown and fuscous; antemedial line formed of fuscous and orange buff scales, the former color predominating, finely wavy and almost vertical from costa to median, shortly incurved below median, then outbent and twice outcurved to middle of inner margin, preceded by a very faint and finer parallel line; discocellular spot white with a fuscous line; postmedial line fuscous with a few orange buff scales, outbent on costa, incurved between vein 7 and 4, vertical to vein 3, then lunular incurved to vein 2, and outbent to inner margin near tornus, followed by a parallel line, fuscous on costa, from vein 7 orange buff mottled with fuscous; an irregular subterminal clear white shade, indentate opposite cell; a fine walnut brown terminal line projecting to cilia above and below veins; the cilia with

short dark spots on interspaces. Hind wing deep brownish drab, the cilia white.

Expanse 65 mm.

Habitat.—Songo, Bolivia.

Type.—Cat. No. 33383, U.S.N.M.

Five males from the Dognin collection.

Nearest to *L. favilla* Dognin, broader winged and differing in genitalia.

EUNOTELA CHACOA, new species

Male.—Palpi, head, collar, and thorax buffy brown, the tegulae pale olive gray mottled with white and a few black scales. Abdomen grayish shaded with hair brown; long tufts of hairs at base, white broadly tipped with black. Fore wing: Base chiefly clay color crossed by some subbasal black scales, and followed by an antemedial hair brown shade limited by a double fine fuscous line; medial space grayer in tone; a mars brown line on discocellular partly edged with white; postmedial line fine, fuscous, edged with whitish, excurved on costa and opposite cell, slightly angled at vein 4, then lunular, and incurved below vein 2; vein 3–6 beyond postmedial streaked with fuscous; an outer hair brown shade, inbent to postmedial angle at vein 4, then very faint to inner margin; a submarginal fine fuscous line, straight from vein 8 to vein 4, then wavy preceded by some whitish and buffy brown shading. Hind wing white; a very fine terminal brown line and small cluster of scales before anal angle.

Expanse 27 mm.

Habitat.—El Chaco, Argentina.

Type.—Cat. No. 33384, U.S.N.M.

APELA ARCHIMMA, new species

Male.—Antenna with short bristles. Palpi, head, collar, and thorax fawn color mottled with white tipped hairs; tegulae dorsally fuscous, laterally light buff. Fore wing cinnamon rufous slightly suffused with purplish; inner margin with produced lobe; a subbasal obliquely curved wavy black line, partly edged outwardly with white; antemedial line outbent and curved, fine, white outwardly edged with burnt sienna; postmedial line from apex to beyond lobe on inner margin, fine, white, inwardly edged with burnt sienna; an orbicular annulus in cell, and a larger annulus over discocellular, both defined by dark lines; some black irroration on terminal area and some pale vinaceous fawn scales at tornus. Hind wing suffused with fawn color, the costa light buff, the cilia tipped with white.

Expanse 37 mm.

Habitat.—Bocas, Rio Ica, Amazons.

Type.—Cat. No. 33385, U.S.N.M.

From the Dognin collection.

DOTTIA BOLIVIATA, new species

Male.—Palpi black above; a lateral wood brown streak; base of cilia fuscous tipped with light drab. Head citrine drab mottled with army brown. Collar mostly citrine drab. Tegulae army brown. Abdomen above hair brown, at base buffish; anal segment with a a black line edged with white, laterally kaiser brown; underneath light buff with a ventral black line. Fore wing: Base of costa and cell hair brown, below cell ochraceous buff with some tawny scales, the whole limited by a faint dark line outangled on fold, followed by another dark line from costa to within cell; a medial dull chamois shade from costa to lower angle of cell, and along costa to apex; discocellular finely black followed by fine russet streaks above and below vein 5, the upper streak reaching termen; three indistinct fine sayal brown lines beyond cell, slightly wavy; veins from cell deep olive buff; terminal area mottled chamois and olive ocher; the veins terminally edged with hair brown expanding on margin and extending on cilia; cilia chamois on interspaces, the inner margin is partly suffused with tawny. Hind wing smoky hair brown with a pale shade postmedially. Fore wing below hair brown, the interspaces terminally buffish. Hind wing below buffish; a dark medial line, the veins terminally broadly hair brown.

Expanse 47 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33386, U.S.N.M.

Collected by J. Steinbach.

PAMCALOMA ABBA, new species

Male.—Palpi carob brown fringed below with white and drab gray hairs. Frons carob brown, with whitish hairs at sides and below. Vertex, front of collar dorsally, and front of thorax dorsally ochraceous tawny with some white hairs, collar otherwise, and mesothorax fuscous; tegulae and metathorax mouse gray, the former with some wood brown and white hairs. Abdomen above deep mouse gray, the two terminal segments thickly irrorated with white, the base dorsally drab gray; underneath warm buff. Fore wing below cell, and terminally from vein 5 to inner margin chiefly silvery pallid neutral gray scales on a whitish ground with a brownish tinge according to light; base of costa mottled with brown and steel gray; a white basal line on costa, edged by a fuscous line, outbent below cell; antemedial line double, fuscous, outbent on costa and cell, filled in with benzo brown mottling, below cell lunular wavy and downbent; double medial fuscous lines on costa wavy, single and faint below cell; a carob brown line on discocellular broadly edged with ochraceous buff; postmedial line remote, incurved from costa to vein 3, consisting of double black lunules, filled in and followed by snuff

brown, below vein 3 inbent without brown shading except on inner margin; subterminal line black, irregular, dentate, outbent to termen above and below veins where they are connected, inwardly edged with light ochraceous buff; a white spot on costa close to apex, preceded by three white costal points; cilia mottled white and brown. Hind wing benzo brown with a faint dark terminal line; cilia tipped with whitish. Wings below drab, with light buff and white mottling at base, more so on hind wing; costa of fore wing finely light buff on basal half, followed by three white points and an apical white spot.

Expanse 45 mm.

Habitat.—Incachaca, Bolivia.

Type.—Cat. No. 33387, U.S.N.M.

Allied to *P. marita* Schaus.

HEMICERAS URSARA, new species

Male.—Palpi brownish vinaceous; fringe of second joint white irrorated with wood brown, of third joint white. Head, collar, and thorax vinaceous fawn, some white hairs on vertex. Abdomen above fawn color; anal hairs and underside buff white. Fore wing vinaceous fawn thickly irrorated with vinaceous buff; a slightly outcurved antemedial line, light ochraceous buff outwardly defined by vinaceous fawn; an oblique black spot on discocellular; postmedial line from costa at 3 mm. from apex to middle of inner margin, fawn color, outwardly edged with light ochraceous; veins terminally finely whitish; some irregular subterminal faintly darker shading. Hind wing whitish, almost completely suffused with fawn color; cilia broadly tipped with white; the stigma not darker.

Expanse 45 mm.

Habitat.—Chiriqui, Panama.

Type.—Cat. No. 33388, U.S.N.M.

Nearest *H. unimacula* Dyar.

HEMICERAS LIBORIA, new species

Male.—Palpi hazel above, buff white below. Frons hazel with a whitish buff spot. Vertex pale pinkish cinnamon, the tuft at base of antennae white. Collar, thorax, and abdomen above brownish drab, the tegulae laterally broadly vinaceous buff. Anal tufts white, the abdomen below light buff with some light vinaceous cinnamon scaling toward anal segment. Fore wing light pinkish cinnamon thickly irrorated with sorghum brown, the lines light ochraceous buff; a sinuous subbasal line, outbent; antemedial line slightly sinuous, and somewhat outbent; a hair brown thick streak on discocellular and two small spots, one before it at subcostal, the other beyond at base of vein 6; postmedial line remote from apex inbent shortly on costa and slightly curved to vein 2, then incurved to inner margin; a faint

subterminal dark shade. Hind wing chiefly light buff; a broad fawn color shade from base before inner margin to termen, the stigma army brown; some fawn color suffusions on termen; costa postmedially light ochraceous buff; cilia slightly tipped with white, wings below light buff, the apical third of fore wing mostly suffused with vinaceous cinnamon.

Expanse 50 mm.

Habitat.—St. Laurent, French Guiana.

Type.—Cat. No. 33389, U.S.N.M.

From the Dognin collection.

Allied to *H. modesta;* differs in color and in having a subbasal line.

HEMICERAS TURIAFA, new species

Male.—Palpi prout's brown, the fringe pale pinkish cinnamon. Head, collar, and thorax mottled cinnamon and white, the frontal tufts with white predominating; tegulae dorsally edged with white. Abdomen above drab, the base with long avellaneous hairs; underneath light buff. Fore wing with the inner margin straight, silky fawn color with a slight olive tinge slightly irrorated with whitish; some light buff hairs at base of inner margin, the lines fine, prout's brown; basal line outwardly pale edged forming a lunule on costa and one below cell; antemedial line inwardly edged with whitish, outangled on costa and in cell at vein 2, incurved to vein 1 and outcurved; medial space below fold to tornus thickly mottled with fuscous and lilac gray scales; the discocellular and veins from cell fuscous irrorated with white, cut by the postmedial line which is finely edged with white, also with white points at some of the veins, straight from costa well before apex to vein 1 and is slightly outcurved below it; costal edge finely white except at base; a subterminal fuscous shade parallel with postmedial; terminal interspaces without white irrorations. Hind wing and stigma cinnamon drab; cilia white.

Expanse 31 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33390, U.S.N.M.

HEMICERAS CLIMACA, new species

Male.—Palpi above hay's russet, second joint fringed with whitish irrorated with russet hairs, first joint fringed with pure white. Head, collar, and thorox vinaceous cinnamon thickly mottled with white hairs. Abdomen above suffused with light pinkish cinnamon; underneath buff white. Fore wing light cinnamon drab, darker shaded medially from cell to inner margin where it extends beyond postmedial line; costa narrowly white to postmedial line; a small subbasal black and white spot below cell; lines light buff finely darker shaded on

medial sides, both from just below costa; antemedial line almost vertical, the postmedial remote from apex to close beyond middle of inner margin; subterminal darker shading from costa to vein 2; the veins white irrorated with fuscous. Hind wing white, the termen narrowly suffused with cinnamon drab, the stigma the same color.

Expanse 34 mm.

Habitat.—Paso de San Juan, Mexico; Chiriqui, Panama.

Type.—Cat. No. 33391, U.S.N.M.

Belongs to the group of *H. transducta* Walker.

HEMICERAS JOINVILLIA, new species

Male.—Palpi cameo brown above; second joint mottled white and fuscous laterally and below, the third joint fuscous at base fringed with white. Head, collar, and thorax mottled buffy brown and white. Abdomen above benzo brown, underneath and anal hairs light buff. Fore wing glossy buffy brown, the veins fuscous irrorated with white, the white irrorations spread over the wing; inner margin deeply lobed; lines army brown; antemedial line straight, outbent to lobe, inwardly edged with buffish; postmedial line remote from apex inbent to inner margin just beyond lobe, outwardly edged with light buff; space beyond line to near termen darker shaded, its outer edge wavy; three very faint dark discal marks. Hind wing whitish, mostly suffused with bronzy cinnamon drab, the stigma benzo brown. Fore wing below with inner margin white, otherwise mostly suffused with benzo brown. Hind wing below buff white.

Expanse 40 mm.

Habitat.—Joinville, Brazil.

Type.—Cat. No. 33392, U.S.N.M.

From the Dognin collection.

Allied to *H. dentata* Dognin and *H. postica* Maassen, both having the postmedial line remote from apex and a lobe on inner margin; in *H. dentata* the lobe is equally pronounced, in *H. postica* less so.

HEMICERAS CHROMONA, new species

Male.—Palpi snuff brown above, underneath white, suffused toward end with sayal brown. Frons vinaceous cinnamon with a white line between antennae. Collar vinaceous cinnamon, finely edged behind with white. Thorax vinaceous buff. Abdomen above suffused with light drab, underneath buff white. Fore wing vinaceous buff produced by cinnamon buff thickly irrorated on a pinkish buff ground; the lines fine, straight, the antemedial nearly vertical, fuscous, inwardly pale edged, the postmedial from costa at apex to near middle of inner margin, cinnamon, inwardly darker edged, outwardly pale edged; a small round black spot at end of cell, sometimes almost evanescent; small dark subterminal points on veins 3 and 4.

Hind wing and stigma light buff, the termen broadly suffused with cinnamon drab, diffuse basad; cilia tipped with white.

Expanse 35 mm.

Habitat.—Hyutanahan and Nova Olinda, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33393, U.S.N.M.

Comes nearest to *H. flavorufa* Dognin.

HEMICERAS TEFFEA, new species

Female.—Antenna with minute bristles. Palpi mikado brown fringed below with white. Head and collar cinnamon; a white band across frons at antennae. Thorax and base of abdomen light pinkish cinnamon; abdomen above silvery drab gray with buffish segmental lines, underneath buff white, the terminal segments suffused with cinnamon buff. Fore wing silky vinaceous drab, the termen broadly hessian brown; costa light pinkish cinnamon and an oblique fascia from base of costa and inner margin narrowing to a point before tornus; a darker shade in cell, and below cell to postmedial line; an indistinct fuscous spot on discocellular; only a postmedial line remote from apex, parallel with termen, vinaceous drab defined by dark lines. Hind wing almost entirely suffused with bronzy cinnamon drab, more heavily on termen; cilia tipped with white.

Expanse 34 mm.

Habitat.—Teffe, Amazons.

Type.—Cat. No. 33394, U.S.N.M.

Unlike any known species.

From the Dognin collection.

HEMICERAS TAPERINHA, new species

Male.—Palpi walnut brown above, light buff below. Head, collar, and thorax mottled amber brown and white, the white hairs predominating on tegulae and metathorax. Abdomen above sorghum brown; anal hairs and underside white. Fore wing with termen crenulate, light cinnamon drab slightly suffused with pale ecru drab on inner margin, the costal margin and medial area thinly irrorated with white; subbasal line lunular, hazel; antemedial line from near middle of costa, excurved on costa and in cell, white, outwardly edged with hazel, then only hazel, shortly inbent on median, vertical to vein 1, and outcurved, with a black point on vein 1, and dark scaling on curve below it, followed in cell by an ochraceous buff shade; a small dark annulus on discocellular, and a small spot above it basad; postmedial line remote, outbent on costa, white, angled on vein 7, then inbent, hazel, cut by veins; the veins from cell and vein 1 chestnut brown irrorated with white; subterminal small darker shades from apex to vein 2, expanding below veins 4 and 3. Cilia with white

points or lines on crenulate curves. Hind wing dull cinnamon drab, whitish at base of cell and costa; cilia tipped with white.

Expanse 35 mm.

Habitat.—Taperinha, Amazons.

Type.—Cat. No. 33395, U.S.N.M.

Four males from the Dognin collection.

Very similar to *H. angulata* Schaus which has termen of fore wing straight.

HEMICERAS REYBURNI, new species

Male.—Antenna pectinated on less than basal half. Palpi and frons tawny mottled with a few whitish hairs. Vertex, collar, and thorax tilleul buff, with some verona brown irrorations forming a slight line on tegulae. Abdomen above drab gray suffused with verona brown on last two segments, the anal hairs and underside buff white. Fore wing: Basal area whitish irrorated with verona brown and crossed by a curved subbasal lunular line formed of black and fuscous scales, followed by an oblique drab shade from costa across cell; basal area limited by the fine, black, deeply wavy, antemedial line inwardly edged with light buff, and followed by a broad white shade from below cell to inner margin; medial area whitish thickly irrorated with cinnamon drab; a small fuscous spot on discocellular, and a large fuscous spot on inner margin before postmedial line; postmedial line outbent on costa, then wavily inbent to inner margin near middle, verona brown outwardly edged with light buff and followed by a small fuscous spot on inner margin; terminal space suffused with benzo brown, the veins mottled white and fuscous. Hind wing dull benzo brown; cilia tipped with white.

Expanse 35 mm.

Habitat.—Teffe, Amazons.

Type.—Cat. No. 33396, U.S.N.M.

From the Dognin collection.

Allied to *H. commentica* Schaus.

Named for Mr. Samuel W. Reyburn, the second subscriber to the Dognin fund.

HEMICERAS HIDULPHA, new species

Male.—Palpi and frons vinaceous brown, the second and third joints of palpi tipped with white; vertex white. Collar and thorax dark vinaceous brown; a large patch on metathorax and base of abdomen dorsally white mottled with olive brown. Abdomen above deep brownish drab, underneath light buff. Fore wing dark vinaceous brown, the costal edge white; a few white scales at base; antemedial white points from subcostal to vein 1; inner margin deeply lobed and excised before tornus; a very few scattered white scales on medial area; outer line from costa before apex, lunular-white from costa to

vein 6 and from vein 2 to inner margin, punctiform on veins 5–3; termen partly suffused with prussian red. Hind wing and stigma benzo brown, the base of costa and cell whitish. Fore wing below cinnamon drab; a large light yellow patch from base below cell to inner margin, not reaching termen. Hind wing below light yellow; a streak at base of costa and terminal suffusions between veins 7 and 2 cinnamon drab.

Expanse 41 mm.

Habitat.—Nova Olinda, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33397, U.S.N.M.

Unlike any other species.

HEMICERAS JOVITA, new species

Male.—Palpi, collar, and thorax cameo brown suffused with purple, the vertex white. Abdomen above brownish drab suffused with cameo brown on basal segments, underneath drab with drab gray transverse lines on medial segments. Fore wing purple drab; base and inner margin broadly suffused with cinnamon brown; lines cinnamon brown; antemedial indistinct, vertical, lunular; outer line near apex, inbent to submedian fold and upbent to near cell and antemedial line, outwardly suffused with darker purple drab; a black and light drab spot on discocellular; clusters of pale drab gray scales on antemedial space below cell and vein 1; the inner margin slightly rounded near base. Hind wing white somewhat suffused on interspaces with drab; stigma benzo brown.

Expanse 35 mm.

Habitat.—São Paulo de Olivença, Amazons.

Type.—Cat. No. 33398, U.S.N.M.

From the Dognin collection.

Unlike any described species.

HEMICERAS PHOCAS, new species

Male.—Palpi above kaiser brown, underneath light buff and vinaceous. Head, collar, and thorax kaiser brown; a white band between antennae. Abdomen above brownish drab; anal hairs and underside vinaceous fawn. Fore wing fawn color suffused with purplish; costal edge hair brown; a dusky dull violet streak below it with some bluish white irrorations; antemedial area below cell pale brownish drab limited by a fine chestnut brown line straight and outbent from costa to submedian vein with a white point on it, then slightly outcurved, paler; a dark oblique streak on discocellular; postmedial line remote, chestnut brown, from below costa, slightly outbent, below vein 7 inbent consisting of small points on veins, below vein 3 very faintly connected by a dentate line, a pale brownish drab shade on outer

side on inner margin; a subterminal benzo brown shade over veins 7 and 8; an oblique sayal brown shade from vein 5 to vein 3 near termen; a medial white point on vein 1. Termen rounded below apex then inbent and curved to slight antemedial lobe on inner margin. Hind wing whitish, the veins dark; inner margin hair brown; suffusions on termen and stigma sayal brown.

Expanse 40 mm.

Habitat.—São Paulo de Olivença, Amazons.

Type.—Cat. No. 33399, U.S.N.M.

From the Dognin collection.

Near *H. nigracosta* Schaus; differs in shape of fore wing and lines.

HEMICERAS PRAXIDES, new species

Male.—Wing shape as in *H. eustalhia* Schaus. Palpi above prout's brown, underneath white, mottled with pinkish buff at end of second joint, the third joint tipped with white. Head, collar, and thorax cinnamon rufous; some white hairs on frons and between antennae. Abdomen above cinnamon drab, the anal hairs and underside white except the last three segments which are suffused with vinaceous buff. Fore wing vinaceous fawn; costa deep neutral gray streaked with fuscous black and some white scales on subcostal; a fine outbent dark basal line; antemedial line fine, natal brown, outbent, straight from costa to submedian fold, then finer and sinuous; a similar oblique line on discocellular; outer line remote from apex, fine, lunular dentate, fuscous from vein 8 to vein 6, below 6 barely indicated except as black and white points on veins; an oblique cinnamon shade from below vein 5 to vein 3; a subterminal fuscous shade from vein 8 to below 5, broken by the veins; a few white scales at apex and terminally on vein 8; cilia cinnamon brown. Hind wing white, the stigma and termen very narrowly cinnamon brown; cilia white. Hind wing below entirely white.

Expanse 42 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33400, U.S.N.M.

Differs from *H. phocas* Schaus in the white hind wing.

HEMICERAS EUSTALHIA, new species

Male.—Palpi chestnut brown above, underneath white, mottled at end of second joint with pinkish buff. Frons pinkish buff; a white line between antennae; vertex, collar, and thorax pinkish cinnamon. Abdomen above hair brown, the anal hairs and underside white; a light pinkish cinnamon shade ventrally on last two segments. Fore wing: Costa straight, apex acute, termen and tornus obliquely rounded to near base of inner margin, then obliquely upbent, vinaceous fawn; costa iron gray; base narrowly deep mouse gray; medial space deep

mouse gray edged basally by the fine iron gray antemedial line which is outcurved from costa to median and twice slightly lunular to inner margin, outwardly edged by an oval iron gray spot on discocellular, containing some sayal brown scales, and from vein 3 by the lunular postmedial line; between veins 3 and 5 the postmedial is obsolescent, but there is a small oblique cinnamon shade from below vein 5 to vein 3; at costa the postmedial is followed by a broad, irregular, subterminal iron gray shade to vein 6, and a similar small spot before tornus; cilia tipped with iron gray. Hind wing white; inner margin suffused with drab gray; veins finely dark; termen very narrowly cinnamon drab, the stigma deep brownish drab; cilia white. Hind wing below entirely white.

Expanse 45 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33401, U.S.N.M.

HEMICERAS ELPHEGA, new species

Male.—Palpi pale cinnamon buff, streaked above with russet. Head, collar, and thorax vinaceous fawn; a white line between antennae. Abdomen above avellaneous; anal hairs and underside buff white. Fore wing vinaceous fawn, lines fine, black; a black and white basal point below cell; antemedial line outcurved in cell, wavily outbent below cell, with black points on veins; a faint brownish curved line on discocellular with a black point above it; postmedial line inbent from near apex, crenulate, followed from apex to vein 6 by a narrow fuscous shade, at vein 1 outcurved; inner margin excurved at base. Hind wing white; stigma and narrow terminal suffusions bronzy vinaceous fawn.

Expanse, male, 44 mm.; female, 49 mm.

Habitat.—St. Laurent, Maroni River, French Guiana.

Type.—Cat. No. 33402, U.S.N.M.

Three males and one female from the Dognin collection.

Near *H. quebra* Schaus, which has the postmedial line punctiform.

HEMICERAS MONEGONDA, new species

Female.—Differs from *elphega* in the following respects. Palpi vinaceous fawn, the first joint fringed with white. Fore wing: The base faintly paler limited by the antemedial line which is outbent to middle of cell, then downbent and sinuous; costal margin fuscous; an oblique fuscous streak on discocellular; postmedial line inbent from costa toward apex to submedian fold, then vertical, followed by a small darker shade on inner margin; a faint subterminal dusky shade from vein 5 to termen at vein 2 and tornus fawn color. Hind wing white, veins and termen narrowly cinnamon buff; cilia white suffused with cinnamon buff at base.

Expanse 55 mm.

Habitat.—Guapiles, Costa Rica.

Type.—Cat. No. 33403, U.S.N.M.

HEMICERAS ARBOGASTA, new species

Female.—Palpi above mikado brown, underneath white suffused with light pinkish cinnamon toward end. Head, collar, and thorax orange cinnamon, the tegulae suffused with vinaceous drab. Abdomen above light drab, underneath vinaceous fawn. Fore wing fawn color; antemedial line fine, black, outbent and curved across median, inangled, slightly outbent forming two slight lunules, with black points on veins, preceded by a slight cinnamon rufous shade; a slight blackish line on discocellular, and dark shade medially from below cell to inner margin; postmedial line from costa well before apex, fine, black, lunular with black points on veins, below vein 2 incurved, followed by a broad cinnamon rufous shade, more distinct from costa to vein 5 and from vein 2 to inner margin; an oblique cinnamon brown shade from vein 4 to below vein 3 and termen near tornus. Hind wing whitish, the veins and termen broadly pinkish cinnamon; cilia tipped with white.

Expanse 49 mm.

Habitat.—Nova Olinda, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33404, U.S.N.M.

The inner margin of fore wing is only slightly sinuous.

The nearest allied species is *H. brunnea* Schaus.

HEMICERAS TURNINA, new species

Male.—Palpi, head, collar, and thorax vinaceous fawn, the palpi fringed below with white. Abdomen above cinnamon drab, underneath fawn color. Fore wing avellaneous suffused with vinaceous fawn, the lines fine, wood brown with well marked black points; antemedial line with the subcostal and point on fold in a line, the point on median and vein 1 outset, the line darker on inner margin; postmedial line with points inbent to middle of inner margin, the faint connecting line better defined below vein 2, outangled from 2 to point on fold, and forming a lunule on inner margin; very faint subterminal darker shading; a fine dark streak on discocellular. Hind wing whitish suffused with fawn color, especially on termen, the stigma benzo brown, cilia tipped with white.

Expanse 46 mm.

Habitat.—Yahuarmayo, Peru.

Type.—Cat. No. 33405, U.S.N.M.

From the Dognin collection.

Allied to *H. subochraceum* Walker.

HEMICERAS VINVALA, new species

Male.—Palpi natal brown above, fringed below with light buff and white. Head, collar, and thorax silky avellaneous; some white hairs between antennae. Abdomen above wood brown, underneath light buff. Fore wing silky avellaneous; antemedial line wood brown, faint, with slight dark points on veins, almost vertical, outcurved in cell, less so on inner margin; a faint dark line on discocellular; postmedial line from near apex, indicated by dark points on veins to vein 2, then linear and punctiform to inner margin; a faint oblique darker shade before middle of termen. Hind wing and stigma uniform bronzy buffy brown; cilia on termen and inner margin white.

Expanse 49 mm.

Habitat.—Palmira, Colombia.

Type.—Cat. No. 33406, U.S.N.M.

From the Dognin collection.

Allied to *H. subochraceum* Walker.

HEMICERAS NOCTIFER, new species

Male.—Palpi hay's russet irrorated with white, fringed with whitish buff. Head, collar, and thorax kaiser brown, the tegulae dark vinaceous drab, the hairs partly tipped with white; a white band between antennae. Abdomen above dusky drab, underneath vinaceous buff. Fore wing silky sorghum brown; some slight fuscous shading on basal area; antemedial line fuscous, vertical, faintly inangled below cell with some white scales on it at fold and vein 1; medial area suffused with fuscous except in cell before the outbent fuscous discocellular shade; postmedial line from costa at 3 mm. from apex to near middle of inner margin, faint crenulate, with black and white points on veins, outwardly edged from vein 2 to inner margin by a narrow orange cinnamon shade; a subterminal fuscous shade from costa to vein 4, then inset and oblique to termen below vein 2; a fuscous spot on inner margin beyond postmedial line. Hind wing aeneous fawn color; the cilia whitish suffused partly with wood brown.

Expanse 44 mm.

Habitat.—Juntas, Colombia; Juan Vinas, Costa Rica.

Type.—Cat. No. 33407, U.S.N.M.

Closely allied to *H. nubilata* Schaus and *H. pernubila* Dyar. The three species differ in the genitalia. The Museum series of *H. nubilata* Schaus consists of 8 males and 12 females; of *H. pernubila* Dyar 12 males and 18 females; of *H. noctifer* Schaus 6 males and 7 females.

SCHAUSIADES ALMOTHES, new species

Male.—Palpi hay's russet above, white below mottled with hazel. Frons hay's russet; vertex and a broad line between antennae white. Collar hay's russet in front; collar behind and thorax white with

some hazel irrorations. Abdomen above hair brown, paler toward end, underneath buff white. Fore wing white thinly irrorated with hazel; antemedial line fine, outcurved, wavy, marked with some fuscous scales; a faint light drab, oblique shade on discocellular; postmedial line from a small chestnut brown spot on costa, outbent below vein 8 fuscous, fine, deeply lunular wavy, inbent to inner margin at middle; terminal space beyond postmedial from vein 6 to inner margin drab; cilia white irrorated with hazel. Hind wing and stigma cinnamon brown; cilia tipped with white. Hind wing below white; veins terminally and a narrow shade on termen from vein 7 to vein 2 cinnamon; some similar scaling at base of costa.

Expanse 48 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33408, U.S.N.M.

A close ally of *S. lepidodes* Dognin.

HAPIGIA DUPONTI, new species

Male.—Palpi vinaceous drab. Head, collar, and tegulae cinnamon drab, the thorax vinaceous drab. Abdomen above brownish drab or fuscous, underneath light buff suffused with vinaceous. Fore wing light cinnamon drab with three oblique cinnamon drab shades from costa, outwardly bordered with diffuse pale vinaceous drab, the antemedial to middle of inner margin, the medial to termen below vein 2, the outer from postmedial to subterminal at vein 3; an indistinct subbasal grayish line; some grayish scaling on outer edge of antemedial oblique shade; a small gray spot at subcostal before end of cell; two grayish glaucous spots at discocellular, the upper somewhat oblique, the lower curved and projecting on median vein, a cinnamon brown line from costa, outcurved to lower angle of cell, then slightly incurved to vein 1; a postmedial fine outcurved line with black and white points on veins, followed by a short oblique white spot across vein 5, above it from costa a faint whitish dentate line; subterminal small black lunules above and below veins, between 7 and 8 a white bilunular line followed by some grayish glaucous scales; terminal light buff points at veins. Hind wing benzo brown, the cilia on inner margin and termen whitish buff.

Expanse 70 mm.

Habitat.—Amatura, Amazons.

Type.—Cat. No. 33409, U.S.N.M.

Allied to *H. nodicornis* Guenèe.

I take great pleasure in naming this fine species from the Dognin collection in honor of Senator Coleman du Pont, a very generous contributor to the Dognin fund.

HAPIGIA HOLLANDIA, new species

Female.—Head, collar, and thorax vinaceous brown, the tegulae and metathorax deep brownish vinaceous. Abdomen above dark vinaceous drab, underneath light grayish vinaceous suffused with russet vinaceous toward base. Fore wing light russet vinaceous, the oblique lines vinaceous brown outwardly shaded with light brownish vinaceous; a line at base along inner margin to near middle; antemedial line outbent to a finer dark lunular line which follows and joins it on inner margin; the next line from before middle of costa oblique to tornus outwardly edged by the fine double discocellular silver line; postmedial line straight, oblique to vein 4, then double, outbent and curved to below vein 2, then incurved to inner margin; an outer oblique line, slightly excurved to termen at vein 4; a shorter oblique line well beyond it from costa to below vein 6; an irregular subterminal black line inwardly finely edged with white, outangled at vein 6 with broken lunules on interspaces below it; termen deeply crenulate. Hind wing drab, the cilia light buff.

Expanse 90 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33410, U.S.N.M.

Named in honor of Dr. W. J. Holland.

HAPIGIA SMERINTHINA, new species

Male.—Head, collar, and thorax sayal brown, the tegulae salmon buff; a small white spot on thorax. Abdomen above benzo brown, underneath buff white with vinaceous tawny transverse bands toward base. Fore wing cinnamon buff with fine darker antemedial and postmedial wavy lunular lines meeting at middle of inner margin; a small white spot at base of cell; a subbasal line with small spots in and below cell; a large irregular spot at end of cell, chestnut brown edged with white, except on outer edge, containing sea-foam green lines encircling a chestnut brown spot; contiguous on basal side two obliquely placed white edged spots filled in with sea-foam green and a few dark scales; an outer series of black and white points on veins, connected by a faint line; subterminal small white spots on veins larger between veins 4 and 6, followed by a fine, very irregular black line, partly edged with white. Hind wing benzo brown, the costa light buff, not reaching apex; some light buff on inner margin; cilia irregularly tipped with white.

Expanse 66 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33411, U.S.N.M.

Allied to *H. smerinthoides* Walker, but paler, the discocellular spot different and the termen of fore wing evenly curved, not crenulate as in that species.

HAPIGIA APIANA, new species

Male.—Palpi, head, collar, and thorax brownish drab. Abdomen above wood brown, underneath light buff suffused with vinaceous except terminally. Fore wing avellaneous faintly suffused with light vinaceous; faint antemedial, postmedial, and subterminal lines partly punctiform. A small grayish medial spot in cell at subcostal; a similar slightly larger spot at lower angle of cell with a hair brown line above it on discocellular; a glaucous gray spot at costa before apex. Hind wing whitish suffused with cinnamon drab, the inner margin broadly warm buff.

Expanse 57 mm.

Habitat.—Venezuela.

Type.—Cat. No. 33412, U.S.N.M.

From the Dognin collection.

Near *H. repandens* Schaus, but differs in color, the reduced markings, the absence of a spot on upper discocellular, and the pale hind wings.

HAPIGIA ENEANA, new species

Male.—Head and tips of palpi dark purple drab, palpi otherwise and collar cinnamon drab. Thorax vinaceous cinnamon. Abdomen above drab, underneath light buff suffused with vinaceous fawn; anal hairs above vinaceous fawn. Fore wing avellaneous suffused with vinaceous fawn; basal line fine, lunular, irregular, black edged with white on inner side; antemedial black and white points on costa, median and submedian veins; reniform consisting of three black annuli obliquely placed, the inner spot small in cell at subcostal, the other two conjoined, B-shaped, containing a few black scales; postmedial fine, dark, marked with black and white points on veins, curved from costa to below vein 2, and slightly outcurved to inner margin; a faintly darker shade before subterminal which is irregular consisting of small black lunules, with a thicker black line near costa, four white points on costa towards apex. Hind wing silky buffy brown, the cilia tipped with white.

Expanse 60 mm.

Habitat.—Cayuga, Guatemala.

Type.—Cat. No. 33413, U.S.N.M.

Four males and a female in the United States National Museum.

HAPIGIA BEUVEA, new species

Male.—Palpi, head, and collar pecan brown. Thorax cinnamon drab with pecan brown tufts on metathorax. Abdomen above benzo brown with dorsal pecan brown tufts on second and third segments.

Fore wing cinnamon drab; traces of a subbasal and antemedial darker lunular lines, outbent from costa to inner margin; reniform narrow, clay color finely defined by black lines, with a small spot close to it on basal side below subcostal; a darker shade from within cell at reniform to inner margin near postmedial; postmedial line straight, oblique from costa to near tornus, pale grayish vinaceous outwardly dark edged; a faint irregular darker shade before subterminal; no white points on costal edge; subterminal line fine, wavy, lunular, black, preceded by a short white line between veins 7 and 8. Hind wing dark buffy brown.

Expanse 72 mm.

Habitat.—Intaly, Amazons.

Type.—Cat. No. 33414, U.S.N.M.

From the Dognin collection.

Allied to *H. simplex* Walker. Differs in color, postmedial line nearer end of cell, and absence of white points on terminal third of costa.

HAPIGIA MILLSI, new species

Male.—Palpi, head, and collar dark purple drab. Mesothorax and tegulae vinaceous fawn; metathorax burnt sienna; abdomen above fuscous; basal tufts, anal hairs and underside light buff, the latter suffused with vinaceous. Fore wing: A broad cinnamon buff fascia from base of costa to inner margin, oblique, its outer edge forming two large curves, and somewhat suffused with sayal brown, crossed by a basal black line, inbent from costa to median vein; space beyond, except termen fawn color suffused with purple; a vertical dark antemedial line, almost medial, from costa to median vein, then wavily outbent and curved below vein 1 to inner margin; reniform vertical, ochraceous buff, preceded by a smaller similar spot at subcostal; a faint darker shade from within cell slightly outbent to inner margin; postmedial line dark, inwardly edged with light vinaceous fawn, straight and somewhat outbent from costa to vein 1 where it is marked by a white point; termen broadly cinnamon buff, its inner edge slightly incurved from costa, inset and straight from vein 5 to below vein 4, again inset and dentate to inner margin, between veins 3 and 2 the cinnamon buff color extending beyond the dentate edge to postmedial line; four white points on costa towards apex; subterminal line very irregular, partly lunular, black, between veins 7 and 8 replaced by a fine white line. Hind wing buffy brown, the termen shaded with pinkish cinnamon; cilia tipped with white.

Expanse 75 mm.

Habitat.—Santo Domingo, Carabaya, Peru.

Type.—Cat. No. 33415, U.S.N.M.

From the Dognin collection.

Named in honor of the Hon. Ogden L. Mills, a generous contributor to the Dognin fund.

RHAPIGIA, new generic name

It is advisable to employ a new name for those species described as *Hapigia* which have the inner margin of fore wing deeply excised and the tornus lobed. It will include *H. accipites* Schaus as type, *H. aymara* Schaus, *Hapigiodes rotundata* Dognin, *H. klagesi* Rothschild, and the following new species.

RHAPIGIA DEICOLA, new species

Male.—Head, collar, and thorax cinnamon brown, the tegulae apricot buff. Abdomen above benzo brown, underneath buff white, suffused with buff pink. Fore wing to terminal area amber brown; broad subbasal and antemedial outbent lines formed on conjoined pinkish cinnamon spots, the antemedial extending to lobe at tornus, the spots partly divided by small dark lunules; an oval similar spot on discocellular and a smaller spot before it at subcostal; postmedial area lunular wavy on outer edge and crossed by a fine dark out curved line inwardly edged with gray, with points on veins, slightly outbent below vein 2; terminal space pinkish buff suffused with amber brown from apex to vein 3 terminally, crossed by a deeply lunular fine black line, edged with white toward apex. Hind wing dark drab, the costa whitish at base; cilia tipped with white.

Expanse 45 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—In Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33416, U.S.N.M.

RHAPIGIA DEICOLA AGNESA, new form

Male.—Similar to *deicola* Schaus but with a black spot on inner margin at excision, and a black spot across vein 4 on the outer edge of the postmedial area.

Expanse 45 mm.

Habitat.—Hyutanahan, Rio Purus, Brazil.

Type.—Carnegie Museum, Pittsburgh.

Paratype.—Cat. No. 33417, U.S.N.M.

HAPIGIODES ARGENTIDISCATA, new species

Male.—Palpi and head fawn color. Collar and thorax vinaceous buff, the former with army brown shading laterally. Abdomen above benzo brown, the anal hairs and under side light buffish. Fore wing: Lower half, obliquely from costa to near tornus wood brown, otherwise vinaceous buff; a vertical basal line inwardly edged with pale vinaceous fawn; antemedial black points on costa and veins, below median connected by a faint lunular line, the lunule on inner margin deeply outcurved to beyond sinus, preceded by a small black spot on median and vein 1; discal spot large golden silvery,

oblique, preceded by a smaller spot at subcostal; postmedial line strongly inbent to vein 2, then incurved and outcurved across vein 1, army brown, inwardly edged with whitish; some faint wood brown suffusions beyond it, and a cluster of black scales across vein 4; subterminal line consisting of small black lunules, and a silvery and black line above vein 7 outangled on vein 8. Hind wing buffish suffused with buffy brown.

Expanse 51 mm.

Habitat.—Taragua, Santa Catherina, Brazil.

Type.—Cat. No. 33418, U.S.N.M.

Probably a southern race of *H. xolotl* Schaus from Central America; differs in paler coloring; the postmedial line more remote from apex.

SYNONYMY OF AMERICAN SPECIES SUBSEQUENT TO 1901

Tagela noctuiformis Dognin=(*Tachida cossula* Rothschild).
Nystalea longicornis Felder=(*N. picta* Dognin).
Nystalea olivescens Dognin=(*Malocampa obliquata* Schaus).
Nystalea indiana Grote=(*N. guttulata* Schaus).
Nystalea scarra Schaus is possibly the female of *N. postpuncta* Schaus.
Nystalea lineiplena Walker=(*N. cucullia* Felder=*Congruia congrua* Dyar).
Nystalea corrusca Schaus=(*N. nigriplaga* Rothschild).
Nystalea marmorea female Schaus=(*N. mocotana* male Schaus).
Pentobesa valta Schaus=(*P. placida* Schaus=*Dasylophia roberta* Dyar).
Phedosia turbida Moeschler=(*Proelymiotis apicenotata* Dognin=*Bardaxima castaneobrunnea* Rothschild).
Proelymiotis lignicolor Moeschler=(*Dasylophia exusta* Butler=*P. arpia* Schaus).
Lysana plusiana Schaus=(*L. postpicta* Dognin).
(*Elymiotis*) *Crinodes alector* Druce=(*C. crenulata* Schaus).
(*Edema*) *Lepasta lanassa* Druce=(*Lysana parvipuncta* Dognin).
Lepasta majorina Dognin=(*L. gigantea* Rothschild).
Strophocerus flocciferus Moeschler=(*S. striolata* Dognin).
(*Elymiotis*) *Dasylophia basitincta* Dognin=(*D. nigrescens* Schaus).
Dasylophia seriata Druce=(*D. indecoris* Schaus).
Farigia vecina Schaus=(*F. moresca* Schaus).
Farigia basiviridis Dognin=(*F. malomen* Dyar).
Farigia gamarra Dognin=(*F. baladan* Druce).
Hamidonta unca Dognin=(*Drugera muscosa* Rothschild).
Pseudodryas luteopunctata Dognin=(*Marthula aurea* Druce).
Tecmessa annulipes Berg=(*T. phyllis* Druce=*Eunaduna cerurata* Dognin).
Hippia mumetes Cramer=(*H. albopicta* Dognin).
(*Edema*) *Hippia mandela* Druce=(*H. nigricaput* Dognin).
Cerura scitiscripta Walker=(*C. platea* Schaus).
Cerura dandon Druce=(*C. grandis* female Schaus).
Arpema megalopia Schaus=(*Malocampa bucephaloides* Rothschild).
Psilacron luteovirens Felder=(*P. cosmipennis* Dyar).
(*Lirimiris*) *Psilacron mechanica* Dognin=(*Pheosia ockendeni* Druce).
(*Heterocampa*) *Urgedra striata* Druce=(*U. quindinata* Dognin).
Urgedra viridiflava Dognin=(*U. luceria* Druce).
Salluca pistacina Schaus=(*Phastia maricolor* Kaye).
Dicentria violascens Herrich-Schaeffer=(*Rifargia brunnipennis* Kaye).
Dicentria limosoides Schaus=(*D. claricostata* Dognin).

Schizura concinna Smith and Abbott=(*Hatima deba* Druce).
Trichomaplata vittata Wing=(*Ichthyosoma tigniferum* Felder).
Trumanda fifiana Dognin=(*Trichomaplata stigmatica* Rothschild).
Disphragis daona Druce=(*Heterocampa andradora* Dyar).
Disphragis bactrea Schaus=(*Skaphita crocea* Dognin).
Disphragis averna Barnes and McDunnough=(*D. pasathelys* Dyar).
Disphragis baracoana female Schaus=(*D. habilis* male Schaus).
Disphragis edwardsi Druce=(*Muscosa* Hy. Edwards=*D. masta* Schaus)
Disphragis sylla Druce=(*D. novella* Schaus).
Disphragis tharis Stoll=(*D. laeca* Schaus).
Disphragis notabilis Schaus=(*D. normula* Dognin=*D. hemicera* Schaus).
Disphragis externa Walker=(*D. spurca* Schaus).
Hemipecteros similis Druce=(*H. dyari* Schaus).
(*Hardingia*) *Hemipecteros albifera* Dognin=(*H. vatsoni* Schaus).
Malocampa punctata Cramer=(*M. ziliante* Stoll=*M. bifurcata* Sepp).
Malocampa sida Schaus=(*M. canescens* Dognin=*M. sidoides* Schaus).
Malocampa satis Druce=(*M. punctata* Druce=*M. parvipunctata* Schaus).
Magava marginata Schaus=(*Rifargia incurvata* Jones).
Rhuda minor Schaus=(*R. opalistriga* Rothschild).
Rhuda dissona Schaus=(*R. postriangulum* Rothschild).
(*Drymonia*) *Rhuda dimidiata* Herrich-Schaeffer=(*R. endymion* Schaus).
Chadisra flavodiscata Dognin=(*Notoplusia distinguenda* Rothschild).
(*Heterocampa*) *Chadisra lemoulti* Dognin=(*C. hollandi* Schaus).
Chadisra arecosa male Druce=(*C. cacobule* female Dyar).
Chadisra tenuis Schaus=(*Blera costaricensis* Dognin).
Chadisra cuculloides Schaus=(*Boriza lignosa* Dognin).
(*Heterocampa*) *Chadisra corda* Druce=(*Rifargia grisea* Schaus).
(*Rifargia*) *Chadisra collema* female Schaus=(*C. praelauta* male Schaus).
Meragisa submarginata Schaus=(*M. julia* Druce).
Meragisa arida Schaus=(*Eragisa basifera* Rothschild).
Phastia umbrata Schaus=(*P. rufolineata* Dognin).
(*Rifargia*) *Euphastia nubila* Druce=(*E. ophidera* Dognin).
Euxoga argenteopunctata Moeschler=(*E. senilis* Dognin).
Euxoga balba Dognin=(*Lysana caudatula* Schaus).
Rifargia cassandra Schaus=(*Heterocampa longula* Druce).
Rifargia myconos Schaus=(*R. pupula* Dognin).
Rifargia condita male Schaus=(*R. presbytica* female Dyar).
Rifargia xylinoides Walker=(*Heterocampa cloelia* Schaus).
(*Eragisa*) *Rifargia bocra* Schaus=(*R. indiscata* Dognin).
Rifargia litura Schaus=(*R. maculata* Dognin).
Rifargia steinbachi Rothschild=(*Lusura speciosa* Schaus).
(*Eragisa*) *Rifargia nox* Schaus=(*E. tenebrosa* Rothschild).
Rifargia incisura Dognin=(*R. terebroides* Rothschild).
Rifargia mistura Schaus=(*R. cossoides* Rothschild).
Eragisa sabulosa Schaus=(*Meragisa garleppi* Druce).
Maschane frondea Schaus=(*M. costipuncta* Rothschild).
Dylomia fragilis Schaus=(*D. nubiloviolaceus* Rothschild).
Dylomia ciliata Felder=(*D. consobrina* Schaus).
Naprepa houla Dyar=(*N. fusconubilata* Rothschild).
Navarcostes limnatis Schaus=(*Dicentria medulla* Dognin).
(*Anita*) *Kurtia lassa* Schaus=(*Proanita squalida* Dognin).
Anita galibensis Schaus=(*Rifargia basiplaga* Rothschild).
Anita basipuncta Schaus=(*A. costalis* Schaus=*Schizura albocostata* Dognin).
(*Malocampa*) *Kaseria gemonia* Schaus female=(*K. pallida* male Schaus).

(*Malocampa*) *Disphragis mayeri* Schaus=*Notoplusia stricula* Dognin.
(*Malocampa*) *Disphragis broma* Schaus=*Notoplusia dentifera* Dognin.
Rifargia causia Schaus=*Cerura titus* Koehler.
Boriza trajecta Dognin=*Exaereta giacomelli* Koehler.
Ginaldia davidsoni Schaus=(*Rifargia cassandra diminuta* Dognin).
(*Symmerista*) *Pamcoloma mus* Moeschler=(*P. refervens* Schaus).
Hemiceras unimacula Dyar=(*H. furina* Dognin).
Hemiceras nigrigutta Schaus=(*H. yuntasa* Dognin).
Hemiceras obliquicola Walker=(*H. cadoca* Schaus).
Hemiceras affinis Druce=(*H. astigma* Dyar).
Hemiceras meona Cramer=(*Eulophopteryx splendens* Moeschler.)
Hemiceras violascens Guenée=(*H. singuloides* Dyar).
Hemiceras losa Druce=(*H. carmelita* Maassen).
Hemiceras nigrescens Schaus=(*H. obliquiplaga* Dyar).
Hapigia notha Moeschler=(*H. rufocinnamomea* Rothschild).
Hapigia simplex Walker=(*Lobogona hapigia* Felder=*H. ribbei* Druce).
Antaea omana Schaus=(*A. pseudosmerinthus* Rothschild).
Canodia difformis Herrich-Schaeffer=(*Hemiceras pogoda* Dognin).

SPECIES FROM CHINA, INDIA, AND THE PHILIPPINE ISLANDS

SPATALIA BRONACHA, new species

Male.—Palpi above hessian brown, underneath white suffused with tawny toward end. Head and collar chestnut mottled with white. Thorax and tegulae cinnamon rufous. Abdomen above clay color, the dorsal tufts at base and anal tufts bister. Fore wing pinkish buff suffused with vinaceous; apex rounded, termen oblique, even; base of costa and just below cell chestnut brown, limited by an incurved white line, followed below cell by a small oblique silver spot, then by a large triangular silver spot, its base at median, its apex at vein 1, its basal side twice excurved, and edged with hessian brown, its outer edge bordered with ocher red, outwardly edged with hessian brown and then with white, these colors expanding below vein 1; a tawny olive streak above median toward base to termen between veins 5 and 6; a black streak on upper discocellular, and a shorter fuscous streak on lower discocellular; postmedial line double, outcurved and lunular from costa to vein 5, then evanescent to vein 4, below 4 consisting of a single inbent, sinuous hessian brown line to below vein 2; a fuscous point above vein 7 at postmedial; a series of subterminal fuscous spots and lunules, the lunules inwardly edged with white and more remote from termen; cilia mostly hessian brown. Hind wing white, the veins and inner margin cream color; cilia light buff tipped with white.

Expanse 42 mm.

Habitat.—Buitenzorg, Java.

Type.—Cat. No. 33419, U.S.N.M.

NOTODONTA GRAHAMI, new species

Male.—Head, collar, and thorax fuscous, the head and collar thickly mottled with grayish hairs; a large light buff patch on thorax, edged with cinnamon brown and crossed by a similar line. Abdomen above light drab, suffused with prout's brown; underneath whitish. Fore wing: Basal area, except costa blackish brown, outwardly finely edged by faint brownish scaling and a black line outcurved from subcostal, slightly inbent on vein 1, originating from an inbent black line on costa; an antemedial small brownish spot below cell, crossed by a black line; costal margin to above discocellular irrorated with white; medial space from below cell to subcostal white thinly irrorated with blackish brown; a thick black line on discocellular, edged with pure white; a narrow blackish brown shade outcurved beyond cell and inbent to middle of inner margin, followed by a finely wavy black line slightly outcurved on costa, vertical below vein 2, outwardly edged with brownish and followed by a blackish brown suffusion to termen except from vein 4 to apex which is dark drab; traces of small subterminal black spots. Hind wing white, the inner margin drab; a fine dark postmedial line with darker streaks on veins; a broad subterminal blackish brown shade, fainter toward anal angle; a similar terminal line. Wings below pale smoke gray, both crossed by a dark postmedial line; fore wing except inner margin faintly darker irrorated.

Expanse, male, 57 mm.; female, 65 mm.

Habitat.—Mount Omei, Szechuen, China.

Type.—Cat. No. 33420, U.S.N.M.

Named in honor of the Rev. D. C. Graham.

The species is closely allied to *N. moltrechtii* Oberthuer = *N. kotshubeji*, Sheljuzko described from the southern Ussuri district.

CERURA NICETIA, new species

Male.—Palpi, head, collar, and thorax black with a few white hairs. Abdomen above with alternate deep mouse gray and black narrow bands; anal hairs white; underneath white with black bands. Fore wing with the base and outer area drab gray; a small black spot near base of cell, followed by a series of spots on veins; a vertical antemedial black line, the space beyond thickly irrorated with black and white, limited by the black medial line which is slightly inbent to below cell, then outbent to inner margin near postmedial; a short black line on lower discocellular; a fine deep ventral gray line from cell across base of vein 2, parallel with medial line; postmedial line very fine, double, deep neutral gray, incurved opposite cell, very deeply outangled on veins 4, 3 and 2, followed by a thick black line parallel to it, very fine and merely dentate from vein 4 to vein 2, below 2 incurved and more heavily marked; this line is followed from

costa to vein 4 by a broad space thickly irrorated with black and white; terminal black spots on interspaces. Hind wing and cilia white; a black line on discocellular; terminal black spots on interspaces. Fore wing below smoky black, the termen broadly drab gray with terminal black spots.

Expanse 46 mm.

Habitat.—Thirty miles north of Tatsienlu, China.

Type.—Cat. No. 33421, U.S.N.M.

Four males collected by D. C. Graham.

The postmedial line is more deeply dentate than in the species of *Dicranura.*

SOMERA ACASIA, new species

Male.—Palpi ochraceous tawny streaked above with fuscous, the tip white. Head, collar, and thorax mottled white, pale ecru drab and slightly with fuscous hairs. Abdomen above army brown, underneath wood brown. Fore wing silky grayish olive, the lines chiefly black; a double subbasal line, inangled on median, outangled below cell with a projecting line to antemedial; antemedial line vertical, double on costa and from fold to inner margin, preceded by an inbent streak from subcostal to median; a fine line on discocellular, outwardly edged with white; a faint dark grayish olive line outbent and dentate to vein 4, then incurved, macular from vein 2 to inner margin; postmedial line double mostly punctiform, filled in with dark grayish olive from vein 3 to inner margin; a lunular subterminal line partly edged outwardly with pale olive buff, forming small lunules from veins 7 to 4, below 4 incurved, sinuous; an interrupted marginal line; cilia with fuscous spots on interspaces. Hind wing army brown; cilia with vinaceous fawn spots. Fore wing below cinnamon drab, the hind wing pinkish buff, with darker suffusions; both wings with cilia cinnamon brown on interspaces.

Expanse 47 mm.

Habitat.—Assam, India.

Type.—Cat. No. 33422, U.S.N.M.

A very distinct species.

STAUROPUS BRIACHISIA, new species

Male.—Palpi cinnamon brown, streaked with fuscous above. Head and collar prout's brown, the head mottled with white hairs. Thorax white mottled with ochraceous tawny, the tegulae white mottled with prout's brown. Abdomen above cinnamon brown, darker at base; underneath light brownish drab with darker bands. Fore wing white thickly irrorated with brownish drab, the lines diamine brown, fine, on costa thicker; base of costa whiter; a subbasal line from costa inbent to base below cell, followed on costa by a short longitudinal streak; a broken medial line slightly inbent; discocellular spot oval,

outlined with white; postmedial outcurved, minutely wavy, vertical below vein 2, followed on costa by a short curved line and a thick streak below vein 7 to subterminal which is white, wavy, preceded by some dark streaks, almost obsolete from vein 4 to below vein 3; a broken terminal line; cilia with white points at veins. Hind wing cinnamon drab; cilia slightly tipped with white.

Female.—Fore wing more thinly irrorated, the outer half of cell almost white; an antemedial line below cell, close to medial indentate at fold with a fine line to base; postmedial line below vein 4 crenulate. Hind wing light cinnamon drab, with darker suffusions before inner margin.

Expanse, male, 54 mm.; female, 66 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33423, U.S.N.M.

STAUROPUS NITERIA, new species

Male.—Antennae fasciculate. Palpi fuscous, the cilia mottled white and chestnut. Head, collar, and thorax white mottled with black; tips of patagia black, also of tufts on metathorax. Abdomen above cinnamon drab, the last segment mottled white and chestnut, the anal hairs white; underneath pale ecru drab. Fore wing white thinly irrorated with fuscous, still less so on medial area; a black line from base below cell and along vein 1, downturned on inner margin near middle, and some yellowish scales below it at base; a double, antemedial line, consisting of light grayish olive scales tipped with black, inset below cell; a similar fine line across cell before the white discocellular line, which is outwardly edged with black, then broadly with scales similar to antemedial, suffusing with the inner postmedial line; postmedial double, incurved below vein 3 at cell, the outer line below vein 3 broadly edged distally by citrine drab striated with black, this edged with black projecting between veins 2 and 3; an outer oblique citrine drab and black fascia from costa to vein 4; a double marginal series of black lines on interspaces, mostly edged with maize yellow on basal side. Hind wing drab, the basal half cinnamon brown, fuscous on discocellular.

Expanse 48 mm.

Habitat.—Assam, India.

Type.—Cat. No. 33424, U.S.N.M.

STAUROPUS PALLADINA, new species

Male.—Antennae pectinated to near tips. Palpi chestnut, streaked above with fuscous, fringed with white. Frons white medially, chestnut laterally. Vertex and collar mostly white, the latter with a transverse chestnut band. Thorax mottled wood brown and greenish white. Abdomen above cinnamon drab, underneath whitish. Fore wing: Basal third, costa, inner margin, termen from vein 6 to

tornus, median vein, base of veins 2, 3, 4, 6, and 7, and a space along distal edge of outer line from costa to vein 4 light grass green, otherwise brownish drab with some green irrorations on terminal third; lines fuscous; an inbent subbasal dentate line; antemedial line double filled in with whitish and light drab, inbent from costa to vein 1, then outcurved on inner margin and filled in with green; postmedial and outer lines crenulate, parallel; subterminal line fine, wavy, edging the green termen from vein 6 to inner margin. Hind wing cinnamon drab; costa to beyond middle whitish; a double black line filled in with light grass green from costa near apex to vein 6; cilia tipped with white.

Expanse 43 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33425, U.S.N.M.

Six males and a female in the United States National Museum.

STAUROPUS KEBEAE Bethune-Baker

This species[1] is quite abundant in the Philippine Islands and shows great variation. Some specimens agree perfectly with the type, whereas others lose all the conspicuous black markings; however, one female has the fore wing almost entirely black with a broad light buff termen. There are 22 males and 8 females in the United States National Museum.

FENTONIA GUALBERTA, new species

Male.—Antennae pectinated on basal two-thirds. Palpi fuscous fringed with light buff; large white tufts below eyes expanding over palpi. Frons and vertex white mottled with cinnamon brown. Collar and thorax prout's brown mottled with white leaving dark transverse bands; the mesothorax whiter, with some maize yellow scaling, the tegulae predominantly white. Abdomen above cinnamon brown, the last two segments white irrorated with cinnamon; underneath cinnamon buff. Fore wing: Base silvery white limited by a fine double black line outbent to fold; a subbasal black point on subcostal vein, and fine dark line from fold to vein 1, outwardly margined with citron yellow scales; wing beyond light silvery gray with faint drab suffusions medially on inner margin and from cell to costa and termen; a fine medial black line across cell; some black scales before and on discocellular; a fine drab postmedial, lunular dentate, outcurved close around cell and inbent to middle of inner margin; a fine, well defined, double, black outer line dentate near costa, slightly curved and outbent to vein 3, then incurved to inner margin near tornus; a subterminal white shade incurved from apex to vein 3; a marginal black line, straight from costa to vein 4 then

[1] Described in Novitates Zoologicae, vol. 11, p. 378 pl. 5, fig. 52.

slightly lunular. Hind wing cinnamon brown, the cilia tipped with white. Wings below sayal brown, the base of inner margin of fore wing white.

Expanse 42 mm.

Habitat.—Surigao, Philippine Islands.

Type.—Cat. No. 33426, U.S.N.M.

FENTONIA ERCONVALDA, new species

Male.—Palpi, head, and collar cinnamon brown. Thorax in front wood brown with some white scales; tegulae dusky drab with some cinnamon brown hairs dorsally, crossed posteriorly by two chestnut lines. Abdomen above black, underneath benzo brown, the last two segments suffused with buff white. Fore wing fuscous, the costa finely light grayish olive; an antemedial wavy black line; a small black spot at end of cell; a faint outcurved postmedial black line; an outer black lunular line, double between veins 6 and 4 followed by some faint lilacine scaling, and similar scaling before and beyond a marginal interrupted black line; some indistinct benzo brown subterminal shading from costa to vein 4; a black terminal line interrupted by veins; cilia cinnamon brown. Hind wing black, the cilia mottled with cinnamon brown.

Expanse 47 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33427, U.S.N.M.

All the markings on fore wing are indistinct, owing to the fuscous ground color.

FENTONIA ABRAAMA, new species

Male.—Head, collar, and thorax drab gray. Abdomen above grayish olive suffused with cinnamon drab except the last two segments; laterally and underneath light yellowish buff, the venter with fine dark segmental lines. Fore wing: Base light drab; a basal faint chestnut line outbent; subbasal and antemedial fine, wavy, parallel, deep grayish olive lines, outbent to inner margin, the space between grayish olive; medial area whitish irrorated with wood brown, more thickly from below vein 2 to inner margin, this shade extending to termen, the more thinly irrorated portion forming an oblique band beyond antemedial line; a small white spot on discocellular; a browner shade beyond cell, and on termen from vein 4 to costa; postmedial line double on costa, buff brown, otherwise obsolete; an outer broad, irregular, smoky deep neutral gray shade inbent from costa before apex to vein 4, partly defined by black lines, below vein 4 very faint, defined outwardly by grayish between veins 4 and 3, and 2 and 1; small fuscous marginal lunules; cilia mottled white and brown with small fuscous spots at veins. Hind wing dark drab, the cilia tipped with white.

Expanse 50 mm.

Habitat.—Shin Kai Si, Mount Omsi, Szechuen, China.

Type.—Cat. No. 33428, U.S.N.M.

Collected by D. C. Graham.

FENTONIA MANGHOLDA, new species

Male.—Palpi and frons snuff brown, the former streaked above with fuscous. Vertex, collar, and thorax sayal brown; a chestnut line across collar behind; tegulae smoke gray, dorsally edged with bister; metathorax with smoke gray and snuff brown tufts. Abdomen above snuff brown with somewhat paler segmental lines; underneath grayish buff with drab bands; laterally the segmental lines are white, with small hair brown spots between. Fore wing drab finely mottled with smoke gray scales; the cell medially and space beyond suffused with dark mouse gray; antemedial line fine, black, preceded closely by a fainter line; reniform defined by white scaling; postmedial line double, deeply dentate, inbent from vein 4 to middle of inner margin, followed by a velvety black sinuous line partly double to vein 4 where it becomes very faint, lunular, followed by velvety lunules from vein 4 to vein 1; a subterminal cinnamon drab shade, somewhat lunular outwardly, much reduced from vein 4 to inner margin, preceded by some white scaling between veins 6 and 4, and followed by ecru drab shading to termen; marginal black spots inwardly edged with white and partly suffusing with the dark terminal line; cilia light ochraceous buff mottled with benzo brown. Hind wing benzo brown; a faint postmedial pale line; cilia partly white tipped. Wings below benzo brown, the termen of fore wing somewhat whitish on interspaces with an irregular dark terminal line. The female browner, the subterminal shade narrower.

Expanse, male, 51 mm.; female, 56 mm.

Habitat.—Surigao, Luzon, Philippine Islands.

Type.—Cat. No. 33429, U.S.N.M.

FENTONIA CANTIANA, new species

Male.—Head, collar, and thorax chestnut mottled with bluish white hairs, very slightly so on vertex and collar. Abdomen above hair brown, the two basal segments cinnamon drab, the last segment and dorsal basal tuft fuscous; anal hairs cinnamon and white. Fore wing benzo brown thickly irrorated with bluish white scales, less so on terminal area; lines fine, fuscous, very indistinct; traces of an antemedial and a discocellular line; postmedial and outer lines far apart on costa, below vein 4 closer together, parallel, crenulate, the lunules of outer line slightly edged with white distally from vein 3 to vein 1; cilia mostly white. Hind wing snuff brown; cilia mostly white.

Expanse 55 mm.
Habitat.—Suifu, Szechuen, China.
Type.—Cat. No. 33430, U.S.N.M.
Collected by D. C. Graham.

FENTONIA EINGANA, new species

Male.—Head, collar, and thorax dark mouse gray mottled with pale gray. Abdomen above light drab, the last segment and anal hairs pale smoky gray; underneath pale smoke gray. Fore wing: Base drab gray; a black basal line outbent to above vein 1 followed by a fine parallel hair brown subbasal line, and two similar vertical antemedial lines; medial area in cell, below it to inner margin and below vein 2 to termen, also at cell between veins 2 and 3 pale smoke gray minutely covered with darker striae; a cinnamon drab line on discocellular with paler edging, followed between veins 4 and 6 by an iron gray patch, outwardly edged with black forming part of the inner postmedial line which is dentate from vein 4 to vein 2; the outer postmedial line black, outcurved from above vein 4 to vein 2; terminal space grayish olive crossed by the evenly curved subterminal pale smoke gray line; a terminal black line.

Hind wing smoke gray with a darker medial shade and dark streaks on veins.

Expanse 29 mm.
Habitat.—Mount Omei, Szechuen, China, at 4,500 feet elevation.
Type.—Cat. No. 33431, U.S.N.M.

Antennae well pectinated and veins 6 and 7 on hind wing with long stalk.

FENTONIA MAGUILA, new species

Male.—Palpi and frons cinnamon brown. Vertex, collar, thorax, and anal hairs grass green; abdomen above cinnamon brown, underneath buff white with brown segmental bands. Fore wing: Base of costa, cell, below cell to fold and base of inner margin cinnamon buff, the costa with brown irrorations; below fold to inner margin and close to tornus grass green, with a black spot above vein 1 at base; a slight subbasal and antemedial cinnamon brown line becoming pale cendre green across inner margin; medial area on costa and cell cinnamon brown, below cell to fold and on outer area clay color; from antemedial above cell green grass scaling expanding above discocellular to near apex, with a similar curved line on discocellular and a white spot on upper discocellular extending on costa; a smaller white spot on costa near end of green; veins from cell partly green; an outer series of fuscous spots on veins followed by white streaks on veins 3 and 4; green spots terminally on interspaces; cilia cinnamon buff with cinnamon brown irrorations and spots at veins. Hind wing light cinnamon drab with some dark scaling at anal angle.

Expanse 21 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33432, U.S.N.M.

The antennae are well pectinated; veins 6 and 7 on hind wing with long stalk.

Evidently very close to *F. viridinota* Hampson, but much smaller.

Four males and a female in the United States National Museum.

CHADISRA MADENA, new species

Male.—Palpi hessian brown fringed with white. Frons sayal brown; vertex deep brownish drab, the hairs partly tipped with light gray. Collar white edged in front with chestnut. Thorax white suffused with vinaceous buff, the tegulae white. Abdomen above whitish buff suffused with avellaneous except at base and at end. Fore wing largely deep vinaceous gray, mottled with broad fuscous scales; a small white spot at base of cell; inner margin white, expanding beyond base, upbent to cell at vein 2, obliquely downbent to below fold, upbent to vein 2 and oblique to tornus, the lines crossing it deep olive buff; a large antemedial oval spot blackish mouse gray formed of broad scales, each tipped with buff white, from within cell, inbent to inner margin, and narrowly edged with white, followed by a double chestnut line from costa, outbent in cell, inset below cell to fold, very faint from fold to inner margin; below vein 2 to postmedial a trangular chestnut mark; discocellular edged with fuscous and a few white scales; an irregular fuscous line, lunular, outcurved and close to cell, followed by the double postmedial fuscous line, which is crenulate, almost vertical to vein 2 and inbent; this line followed from costa by a large white spot with outer edge wavy, and narrowing to vein 4 largely irrorated with olive and dark olive buff, with two chestnut spots on costa and some buffy brown at apex; subterminal small white spots on interspaces from vein 6 to vein 2; cilia mottled fawn color, wood brown and white. Hind wing cinnamon drab, the base and inner margin partly white; cilia white at anal angle.

Expanse 42 mm.

Habitat.—Tjibodas, Mount Gede, Java.

Type.—Cat. No. 33433, U.S.N.M.

In appearance very much like *Fentonia orbifer* Hampson but with the areole and venation typically that of *Chadisra,* only differing in having the antennae well pectinated for three-fourths of the length.

NEOPHEOGIA CATHANA, new species

Male.—Palpi dark chestnut, the fringe mottled with white. Frons dark chestnut, laterally mottled with white and buff pink. Collar and thorax with a dorsal fuscous line, collar otherwise and tegulae white

mottled with chestnut hairs. Abdomen above drab with fuscous bands except on last two segments; underneath white with some drab shading. Fore wing: Basal half pinkish buff; vein 1 from base chestnut; some white at base of costa followed by two short fuscous lines, the antemedial with a short streak below it in cell; costa to medial line fuscous, the latter forming a blackish mouse gray shade, narrow in cell below cell suffusing with a similar shade on interspaces from vein 4 to inner margin, partly coalescent; two white streaks on costa from medial to postmedial line; a faint dark streak in cell above median; a pinkish buff oval spot an discocellular, containing a small fine brown annulus; interspaces beyond cell, between veins 4 and 6 sayal brown; postmedial line on costa double, oblique, fuscous, filled in with white, the outer line upbent below vein 7 to apex; a wavy pale and faint subterminal line from vein 4 to inner margin followed by thick black streaks on veins 4–2, and on inner margin; cilia fuscous on interspaces tipped with white. Hind wing white; a small fuscous black patch at anal angle.

The female has pectinated antennae, is more uniformly pinkish buff, without the dark postmedial suffusions; the hind wing with the costal margin pinkish buff and wood brown; the termen narrowly and cilia mostly fuscous.

Expanse, male, 58 mm.; female, 70 mm.

Habitat.—Mindanao and Luzon, Philippine Islands.

Type.—Cat. No. 33434, U.S.N.M.

The female is somewhat like *P. fasciata* Moore, which also occurs in the Philippine Islands, but this has simple antenna.

PHALERA ORDGARA, new species

Male.—Palpi and throat chestnut, the former fringed with orange cinnamon. Vertex warm buff. Collar and thorax ochraceous tawny, the tegulae deep mouse gray. Abdomen above chestnut brown with rather broad whitish segmental lines; anal hairs light buff; underneath white laterally, black ventrally, except on last two segments. Fore wing mouse gray, darker in cell and on costa to outer line; a broad black oblique streak from base below cell to inner margin; a fine black subbasal line on costa and cell; antemedial line fine, black, vertical, minutely wavy; a double, very fine postmedial line, well apart, from beyond cell at vein 4 wavily dentate to middle of inner margin, followed between vein 3 and subcostal by deep mouse gray lines to outer line, this latter rather broad, white, vertical from costa to vein 4, incurved between 4 and 3, joined at vein 4 by a crenulate white line from apex, the space between them and termen from apex to vein 3 avellaneous; on outer edge of vertical line small dentate black marks; below vein 3 the outer line is reduced to a fine lunular deep mouse gray line; a terminal cinnamon brown and black dentate

line, enclosing white spots which extend on cilia. Hind wing dark buffy brown, cilia with white spots.

Expanse 60 mm.

Habitat.—Nine to thirty miles from Tatsienlu, China.

Type.—Cat. No. 33435, U.S.N.M.

A very distinct species described from 4 males collected by D. C. Graham. One specimen shows a faint pale discal spot on fore wing.

PHALERA SURIGAONA, new species

Male.—Palpi fuscous fringed with wood brown mottled with a few white hairs. Frons snuff brown. Vertex white. Collar snuff brown. Thorax and tegulae brownish drab; a white line at shoulders. Abdomen above bister with white segmental bands; anal segment and underside yellowish white. Fore wing army brown, paler below cell and vein 2 to inner margin; a broad oblique white shade irrorated with brown from base of costa to antemedial line below cell; traces of a fine black basal line; antemedial line double, well apart on costa, then outcurved and minutely wavy to median, then close together, straight and vertical to vein 1, inbent below it; a double vertical medial line, finely dentate, wavy, inwardly edged with white from below cell; a small buffy brown spot at discocellular; postmedial line double, fine with some black and grayish points on veins, lunular dentate to vein 2, below it sinuous and vertical, closely followed by a fine double lunular dentate line slightly incurved below vein 4, and more heavily marked between veins 2 and 1; a faint fawn color shade from vein 4 to apex, outwardly crenulate; a terminal white patch from tornus to vein 3; submarginal wood brown lunules filled in with black; a terminal cinnamon brown line, extending on cilia at veins, the cilia otherwise cinnamon. Hind wing army brown becoming broadly fuscous on termen; cilia buffy brown with army brown spots at veins. Wings below buffy brown, paler on termen; fore wing with a double army brown, somewhat crenulate, terminal line; hind wing with a vertical medial thick olive brown line from costa to vein 2.

Expanse, male, 80 mm.; female, 112 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33436, U.S.N.M.

Five males and one female in the United States National Museum.

The species is allied to *P. grotei* Moore, which I do not think is identical with *P. raya* Moore. *P. grotei* also occurs in the Philippine Islands, and the Museum has a long series. The genitalia of the two species are very different.

BESIDA VINVALVA, new species

Male.—Palpi: Second joint fuscous, the cilia and third joint drab. Head and collar mottled light buff and cinnamon brown, the latter narrowly fuscous in front; thorax mouse gray. Abdomen above drab

suffused with light buff at base and with a dorsal cinnamon brown tuft; anal hairs whitish buff; underneath buff white with a benzo brown ventral line, and traces of dark segmental lines. Fore wing: A black spot at base, outwardly curved with a black branch at base of median extending to the black space beyond, with an avellaneous shade above and below it crossed by a double sinuous chestnut and black line; cell and just beyond to inner margin fuscous black, the costa and part of inner margin avellaneous; traces of an antemedial and double medial black line, the entire dark space limited by a narrow black shade inbent from costa to inner margin; a double broken light buff line partly edged with velvety black at discocellular; postmedial and terminal area largely suffused with buffy brown, and below vein 2 with light buff, crossed by two broken, somewhat punctiform black lines; a broad subterminal black line, straight from apex to vein 2, its outer edge expanding on veins, followed on interspaces by small velvety black lunules; an oblique white streak at tornus; a terminal black line; cilia fuscous partly mottled with white.

Hind wing dark buffy brown; cilia partly whitish.

Expanse 49 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33437, U.S.N.M.

Close to *B. xylinata* Walker with the type of which it was compared.

LIPAROPSIS DYMPNA, new species

Male.—Palpi and head mottled russet and white. Collar white with a line of black scales anteriorly. Thorax cinnamon brown and fuscous. Abdomen white; some light drab hairs at base and dorsally. Fore wing: Base narrowly white edged by a fuscous line indentate below median; antemedial space sayal brown partly clouded with fuscous, its outer edge oblique to inner margin beyond middle; postmedial line white outcurved below costa with black and white points on veins 5 to 1, followed by short fuscous streaks on veins 6 and 5, and a white space to apex; the medial triangular space formed by the two lines white thickly irrorated with light drab and deep mouse gray; a sinuous white line on discocellular, usually separated into two spots; terminal space below vein 5, and more narrowly on termen to vein 7 sayal brown. Hind wing white; some chestnut irrorations above vein 6 to apex and on costa; a fine terminal black line not reaching anal angle; a fuscous spot on cilia at apex; some light buff suffusions on inner margin.

Expanse 29 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33438, U.S.N.M.

Close to *L. postalbida* Hampson, and *L. formosana* Wilemen.

PYDNA ADJUTREA, new species

Male.—Antenna bipectinated to near tip. Palpi avellaneous streaked above with fuscous. Head and collar grayish olive. Thorax light buff, the front narrowly, a dorsal line, shoulders, and tegulae outwardly bay. Abdomen above light ochraceous buff, underneath cream white. Fore wing whitish buff; base of costal edge bay; cell silvery white; a bay line at base of wing; a subbasal fine cinnamon rufous line, outangled on costa, followed on costa by a cluster of cinnamon scales; an outcurved antemedial amber brown line from costa to median, below cell outcurved to fold; from antemedial in cell to near end a fine amber brown bifurcating line; a fine amber line from antemedial along upper edge of cell, expanding and outcurved at discocellular, at vein 3 joining a thicker amber brown line from base along median; a similar line from apex to vein 2, close to cell, slightly crenulate from vein 4 to vein 2, with some ochraceous buff between it and the line on median; a fine pinkish cinnamon postmedial line outangled on costa, then obsolete; base of veins 7, 6 and 4 to 2 amber brown; outer dark specks on veins 8 to 6; from below vein 4 to antemedial below cell, some pinkish cinnamon scaling; a similar wavy subterminal line from vein 5 to inner margin; submarginal tawny points on interspaces, larger at fold; cilia with ochraceous buff spots at veins. Hind wing light yellowish buff, darker on inner margin. Wings below yellowish white, the cell of fore wing suffused with brownish drab.

Expanse 58 mm.

Habitat.—Assam, India.

Type.—Cat. No. 33439, U.S.N.M.

PYDNA MARCONIA, new species

Male.—Antennae with long pectinations, in the female moderately pectinated. Palpi buff white, streaked above with fuscous. Frons buff white, darkly edged at eyes. Collar and thorax light buff, the tegulae mottled with cinnamon buff hairs. Abdomen above pinkish buff, underneath white. Fore wing light buff thinly irrorated with cinnamon buff and sayal brown; subbasal line indicated as a curved cinnamon line on costa, and a curved black line below cell; a very faint medial line consisting of cinnamon scales sinuous from within cell to inner margin, preceded in cell by a large quadrate black spot; an elongated black spot at end of cell to the postmedial which is similar to the medial line, outcurved from costa, inbent from vein 4 to the medial line at fold; dark scaling on vein 5, upbent to near apex; subterminal black points on interspaces parallel with termen. Hind wing light buff suffused with light pinkish cinnamon especially toward inner margin; cilia white. In some specimens the cell spots are sayal brown.

Expanse, male, 46–48 mm.; female, 58 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33440, U.S.N.M.

A series in the United States National Museum.

PYDNA ODRANA, new species

Male.—Antenna with fine fascicles. Palpi and head light buff, the palpi streaked above with fuscous. Collar avellaneous. Thorax light buff, suffused with avellaneous in front and partly on tegulae. Abdomen above cinnamon, the last segment and anal hairs white; underneath white. Fore wing light buff slightly irrorated with cinnamon, except between veins 2 and 4, and on terminal area from vein 8 to fold; irrorations denser medially below cell and on inner margin; a fine and faint drab line below cell to vein 2, cinnamon scaling on median and discocellular, and a narrow drab shade from above vein 4 to termen below apex; a round black medial spot below vein 2; postmedial black points on veins 2, 3 and 4; a black antemedial point above median; subterminal black points on interspaces from below vein 7, precedeed between veins 4 and 2 by an inbent faint drab shade; inner margin suffused with drab. Hind wing pinkish cinnamon; costa narrowly and cilia white.

Expanse 43 mm.

Habitat.—Surigao, Philippine Islands.

Type.—Cat. No. 33441, U.S.N.M.

PYDNA UBALVIA, new species

Male.—Antenna ciliate. Palpi and head drab gray, the palpi black above. Collar and thorax drab gray; a dorsal hair brown line from vertex to metathorax; tegulae with long light buff hairs from shoulders. Abdomen above cinnamon, the last segment, anal hairs and underside white. Fore wing light buff; costal edge white; a drab line from base along median, from lower angle of cell upbent to apex; an excurved light drab shade from inner margin near base to vein 2 near cell; a faint outcurved postmedial line, sinuous and inbent from vein 5 to vein 2; an outer series of black points on veins parallel with termen and with light drab suffusions from vein 2 to inner margin; subterminal streaks on interspaces from vein 7 to vein 1, preceded from vein 4 by a faint light drab line; cilia tipped with white. Hind wing brownish vinaceous, broadly dark on inner margin; cilia white.

Expanse 45 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33442, U.S.N.M.

PYDNA BARASAMPHIA, new species

Male.—Antennae fasiculate, simple in the female. Palpi hazel above, white below irrorated with hazel at tips. Head, collar, and thorax light buff mottled with fawn color. Abdomen above warm buff, terminal segment, anal hairs and underside white. Fore wing light buff thinly irrorated with tawny; tawny scaling forming a shade along median, at vein 4 upbent to apex; similar scaling forming very indistinct and broken antemedial, medial, and postmedial lines, all outcurved, the postmedial followed by fuscous points on veins, vertical from costa, on vein 6 to 4 small angled lines, below vein 4 inset to inner margin; marginal fuscous points on interspaces. Hind wing maize yellow, cilia tipped with white.

Expanse 33–38 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33443, U.S.N.M.

PYDNA ERCONA, new species

Male.—Antenna and body as in *P. barsamphia* Schaus. Fore wing buff white; some cinnamon scaling forming a line below cell to vein 2, expanding there into a spot reaching fold, then above median, along vein 4 and upbent to apex; a few postmedial and subterminal cinnamon scales; marginal fuscous points on interspaces. Hind wing white suffused with pinkish buff along inner margin.

Expanse 33 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33444, U.S.N.M.

PYDNA GODDRICA, new species

Male.—Antennae fasciculate. Palpi: Second joint dark mouse gray, the fringe and third joint whitish with slight black hairs and irrorations. Head benzo brown. Collar and thorax drab, the tegulae ecru drab. Abdomen above deep olive buff, with dark transverse lines. Fore wing pale pinkish buff, the inner margin to outer line suffused with dark olive buff, the lines dark olive buff; a line from base of cell along median and vein 4 to termen, faintly edged with whitish below; a postmedial line outcurved around cell and inbent to middle of inner margin; traces of an inbent dull darker shade from middle of costa to median and a similar dark olive buff line from fold antemedially to base of inner margin. In one specimen a small black spot on discocellular; an outer series of black points on veins, parallel with postmedial, partly double, and from vein 2 to inner margin triple; a faint, fine darker shade from apex to vein 4, and from termen to vein 1 at outer series of points; marginal black spots on interspaces. Hind wing blackish drab.

Expanse 47 mm.

Habitat.—Shin Kai Si, Mount Omei, China.

Type.—Cat. No. 33451, U.S.N.M.

Received from D. C. Graham.

TURNACA BRYANTIA, new species

Male.—Palpi, head, collar, and thorax mottled wood brown and whitish buff. Abdomen above fawn color, underneath white. Fore wing fawn color thickly irrorated with white, less so along median below cell and vein 4 to termen; inner margin slightly darker, also along vein 6 to termen; faint traces of a double postmedial line and an outer punctiform line. Hind wing fawn color. Wings below cinnamon.

Expanse 60 mm.

Habitat.—Java.

Type.—Cat. No. 33445, U.S.N.M.

Collected by Bryant and May.

Allied to *T. rafflesi* Moore, larger, the hind wing darker.

TURNACA PANTAENA, new species

Male.—Palpi verona brown fringed with white. Head, collar, and thorax whitish buff thinly mottled with sayal brown. Abdomen above mikado brown, the last segment, anal hairs and underside white. Fore wing whitish buff, thinly irrorated with sayal brown; a fine, black line on median and vein 4 to outer streaks; an antemedial sayal brown point on subcostal, median and vein 1, the latter inset; a subbasal point on costa; very faint traces of a double postmedial line; an outer series of short black streaks on veins; fine black terminal streaks on veins 1, 4, and 7; faint brownish marginal points on interspaces. Hind wing pinkish cinnamon, the cilia white. Fore wing below pinkish cinnamon. Hind wing below pinkish cinnamon, the costa pale pinkish buff.

Expanse 35 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33446, U.S.N.M.

Five males in the United States National Museum.

TURNACA SURIGA, new species

Male.—Palpi fuscous fringed with white. Head, collar, and thorax mottled white and sayal brown, the tegulae outwardly entirely white. Abdomen above cinnamon, the last segment and anal hairs white mottled with cinnamon; underneath white. Fore wing white with a few dark scales; inner margin suffused with deep olive buff; some olive buff between veins 2 and 4 at cell; a fine black line on median and vein 4 to outer points, also on base of vein 6; the median vein edged in cell with maize yellow; a broken, oblique, fuscous line on

costa at base; a double outcurved antemedial cinnamon line, not distinct and broken; a similar medial, single line to median where it is preceded in cell by some dark scaling; a double outcurved postmedial line, largely consisting of light pinkish cinnamon scaling on interspaces; a double outer series of small fuscous spots on veins, the veins themselves mostly white; a terminal black streak on vein 4, and some black irrorations between veins 5 and 6 between the points. Hind wing light pinkish cinnamon, broady darker along inner margin; cilia mottled with white.

Expanse 38 mm.

Habitat.—Surigao, Mindanao, Philippine Islands.

Type.—Cat. No. 33447, U.S.N.M.

NORRACA ORDGARA, new species

Male.—Palpi neutral gray above, white below. Head, collar, and tegulae cream buff with a faint olive tinge. Thorax and abdomen above vinaceous fawn, the last segment light buff; anal hairs vinaceous buff; underneath white. Fore wing cream buff; traces of a darker antemedial line; a long white fascia in cell from antemedial to discocellular, divided by a fine longitudinal cream buff line, crossed close to each end by a similar line; postmedial, outer line and subterminal line consisting of small patches of light grayish olive scales, all inbent and parallel with the very oblique outer margin. Hind wing vinaceous fawn, darker shaded near inner margin; costal margin and cilia white. Wings below buffish white.

Expanse 48 mm.

Habitat.—Manila, Philippine Islands.

Type.—Cat. No. 33448, U.S.N.M.

MICROPHALERA STYXANA, new species

Male.—Head, body, and fore wing above blackish brown. Abdomen above with deep neutral gray segmental lines; underneath drab gray. Fore wing silky; a fine velvety black line on discocellular; traces of deep neutral gray antemedial and postmedial lines on costa, the latter outcurved on costa, crenulate, preceded by a short whitish streak on vein 1, and followed on veins 2–4 by faint neutral gray streaks; faint traces of a pale subterminal line from costa near apex; cilia with a few white tipped hairs. Hind wing whitish suffused with drab; costa and termen hair brown, the latter preceded by a clearer white space. Fore wing below deep quaker drab; white spots on costa before apex; a subterminal black shade. Hind wing below white; a submarginal blackish band; cilia pale drab gray tipped with white.

Expanse, male, 38 mm.; female, 44 mm.

Habitat.—Shin Kai Si, Mount Omei, China.

Type.—Cat. No. 33449, U.S.N.M.

Collected by D. C. Graham.

PYGAERA HILDORA, new species

Female.—Palpi and frons russet faintly mottled with whitish hairs. Vertex and collar medially velvety mars brown; collar laterally, thorax and abdomen drab. Fore wing drab, finely irrorated with prout's brown, the lines pale drab gray; antemedial and medial lines parallel, slightly outbent; reniform spot defined by a pale drab gray line down and outbent to vein 1, then upturned to vein 4, very indistinct; postmedial line from subcostal oblique to near vein 3, then rounded and inbent to inner margin, the space beyond to apex and termen above vein 3 raw umber. Hind wing buffy hair brown.

Expanse 44 mm.

Habitat.—Luzon, Philippine Islands.

Type.—Cat. No. 33450, U.S.N.M.

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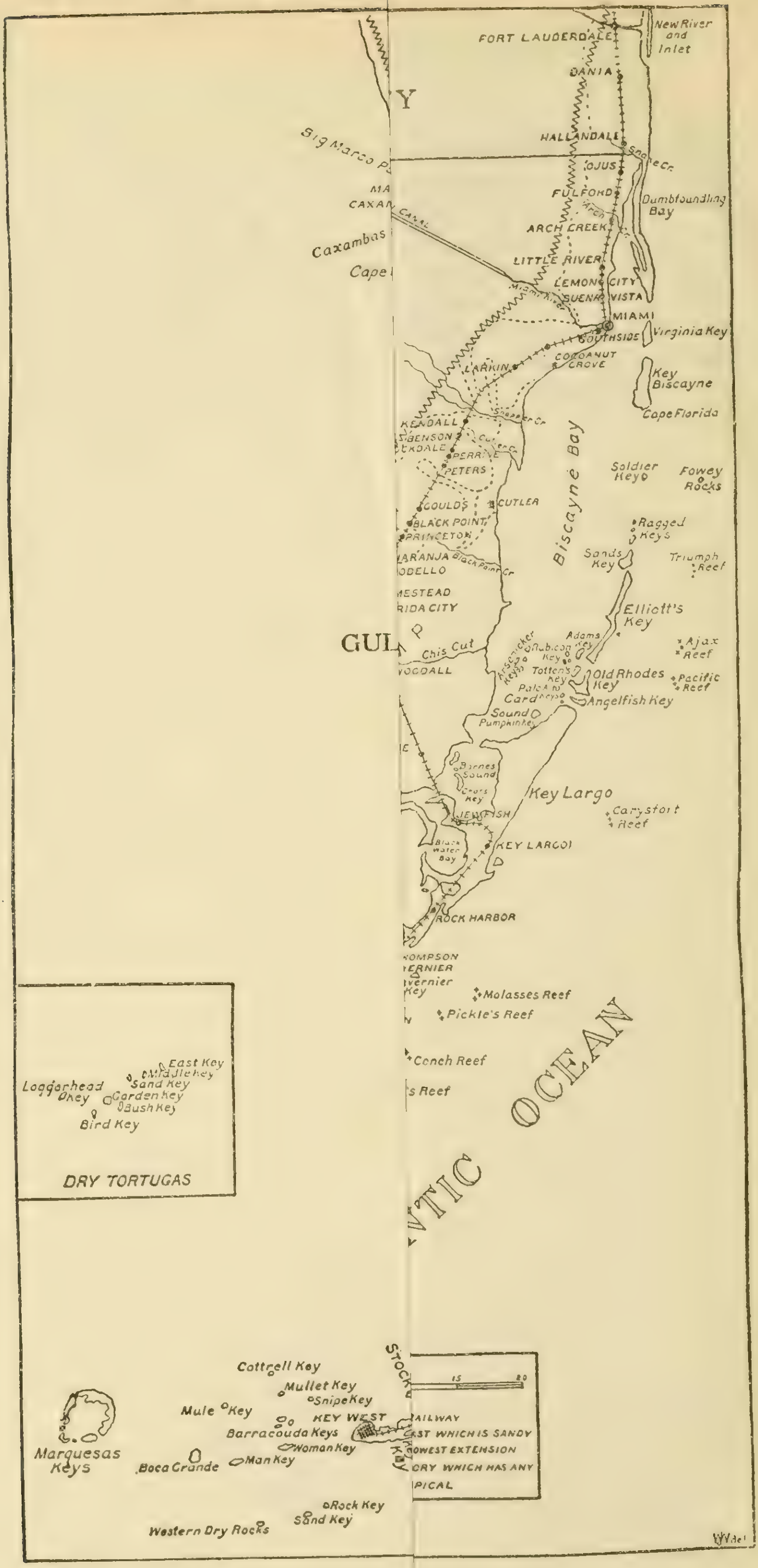

New River and Inlet
FORT LAUDERDALE
DANIA
Y
HALLANDALE
OJUS
FULFORD
Dumbfounding Bay
ARCH CREEK
LITTLE RIVER
LEMON CITY
BUENA VISTA
MIAMI
Miami River
SOUTHSIDE
Virginia Key
COCOANUT GROVE
LARKIN
Key Biscayne
Cape Florida
Caxambas
Cape
CANAL
KENDALL
PERRINE
PETERS
Biscayne Bay
Soldier Key
Fowey Rocks
GOULDS
CUTLER
BLACK POINT
PRINCETON
Black Point Cr.
Ragged Keys
Sands Key
Triumph Reef
Elliott's Key
RIDA CITY
GUL
Chis Cut
Adams Key
Rubicon Key
Totten's Key
Old Rhodes Key
Ajax Reef
Pacific Reef
Angelfish Key
Sound
Barnes Sound
Key Largo
Carysfort Reef
JEWFISH
Black Water Bay
KEY LARGO
ROCK HARBOR
Molasses Reef
Pickle's Reef
Conch Reef
OCEAN
VTIC
East Key
Middle Key
Loggerhead Key
Sand Key
Garden Key
Bush Key
Bird Key
DRY TORTUGAS
Cottrell Key
Mullet Key
Snipe Key
Mule Key
KEY WEST
Barracouda Keys
Woman Key
Man Key
Marquesas Keys
Boca Grande
Rock Key
Sand Key
Western Dry Rocks
Stock

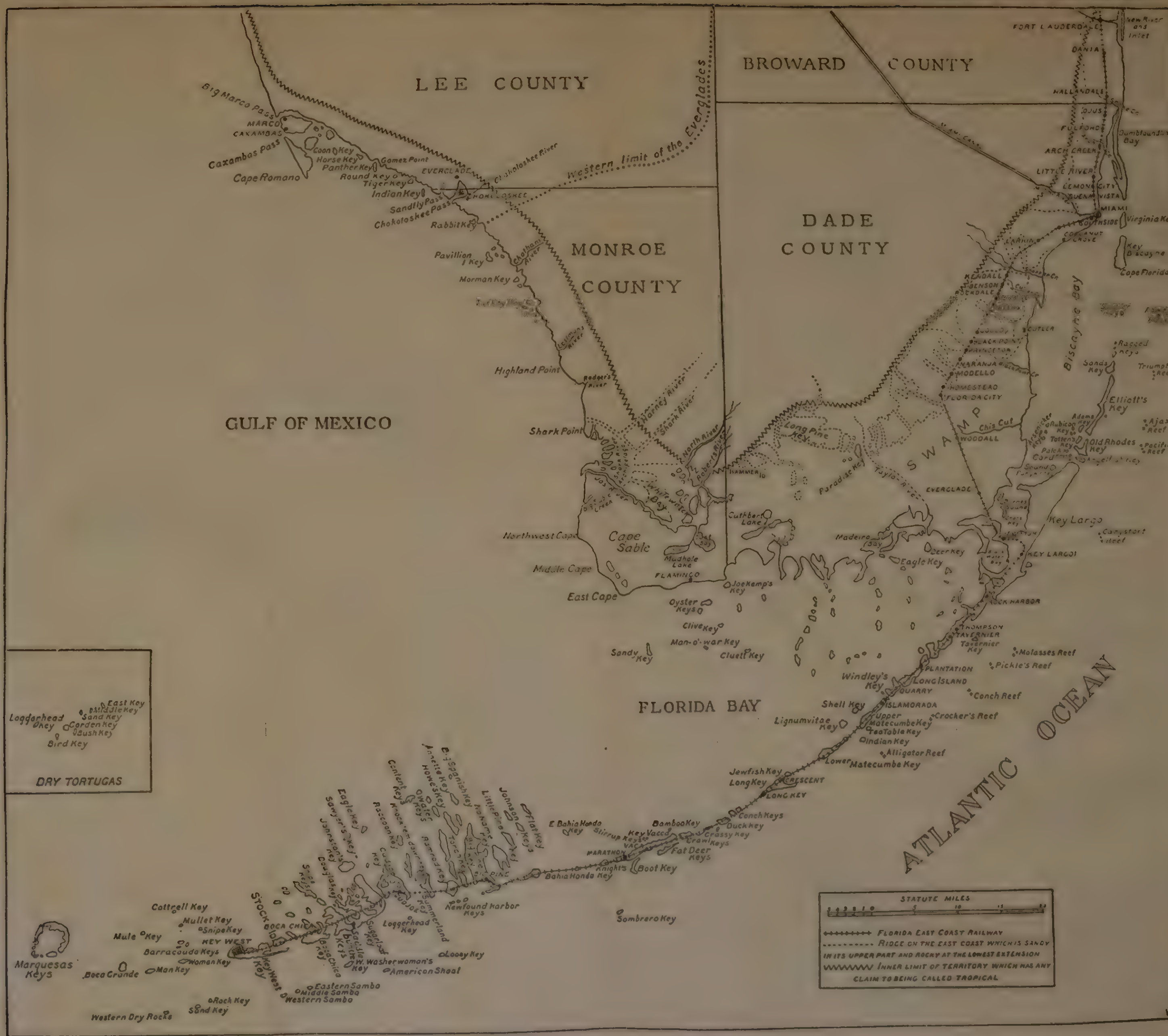
THE FLORIDA TREE SNAILS OF THE GENUS LIGUUS

By Charles Torrey Simpson

INTRODUCTION

The following pages are the result of studies and collections made in the field during a residence of nearly 30 years in southern Florida and of six visits to Cuba which permitted me to work over the island from Cape San Antonio at the west end to within a hundred miles of Cape Maisi at its eastern point. I have also visited Haiti and collected *Liguus virgineus* in considerable quantity. This work on the islands was not at all thorough as it was done in connection with that of getting plants and collecting the land snail fauna in general, but it gave me a considerable amount of *Liguus* material and ideas of its distribution. I have made a rather careful search in Florida, having tramped the East Coast Railroad several times from Key Largo where it enters the Upper Keys to Key West at its terminus and back again. I have visited practically every one of these islands which have ever had *Liguus* and made collections on them. On the mainland I have been in nearly every locality in which these snails were found, and many of these places I have visited and worked over a number of times. In all I have some kind of *Liguus* material from over 300 Floridian localities, most of which I have personally collected. For nearly 26 years I have had an opportunity to study these snails in my own hammock within a hundred feet of my door.

Long before I began to collect (1882) man had wrought great destruction to the hammocks in which they live so that certain forms were on the verge of extinction and in some localities all evidence of them was obliterated, and at present the *Liguus* are almost exterminated in Florida. Great areas of forest have been recently cut in Cuba in order that sugar cane might be grown, and it is probable that it will be a short time only when these snails will be wiped out entirely in many localities in that island. Very much of the evidence necessary to a complete study of them is therefore missing, and the future student will only be able to use material collected


LEE COUNTY
BROWARD COUNTY
DADE COUNTY
MONROE COUNTY
GULF OF MEXICO
FLORIDA BAY
ATLANTIC OCEAN
DRY TORTUGAS
Western limit of the Everglades
Cape Romano
Caxambas Pass
Big Marco Pass
Highland Point
Shark Point
Northwest Cape
Middle Cape
East Cape
Cape Sable
Key Largo
Biscayne Bay
Marquesas Keys
Boca Grande
Western Dry Rocks
Sombrero Key
Newfound Harbor Keys
Bahia Honda Key
Boot Key
Long Key
Lower Matecumbe Key
Windley's Key
Molasses Reef
Conch Reef
Crocker's Reef
Alligator Reef
STATUTE MILES
FLORIDA EAST COAST RAILWAY
RIDGE ON THE EAST COAST WHICH IS SANDY IN ITS UPPER PART AND ROCKY AT THE LOWEST EXTENSION
INNER LIMIT OF TERRITORY WHICH HAS ANY CLAIM TO BEING CALLED TROPICAL

long ago. So much of the evidence as to distribution and other matters is gone that anyone attempting to work out the story of these mollusks finds himself in the position of a person who tries to read an old, torn, and faded book with many of the pages missing.

In Cuba the earlier collectors seemed to think that the different forms of *Liguus* were merely color variations that meant absolutely nothing, so they took but little pains to get complete sets of the varieties or to record definite localities for them, and they mostly lumped all their material together and labeled it "*Achatina fasciata*, Cuba." If only complete collections of *Liguus* could have been made in the island and in Florida before the destruction of the forests began and the records of localities carefully kept I am satisfied that we could not only have deciphered their past history but by their aid we could have worked out in considerable detail the geology of both regions.

It has been objected that I have given too many names to color varieties of the Floridian *Liguus*. While I do not attach any great importance to most of these, yet I am sure that they stand for different phases of development and distribution. It seems to me that it is better to have some kind of a name for a variety, such as *mosieri* or *castaneus*, than to have to say " the small form of *crenatus* with narrow spiral green lines " or " the dark chestnut variety of *fasciatus* having a few yellowish markings on the spire." A considerable number of the *Liguus*, which Dr. H. A. Pilsbry and I have named, are, doubtless, fertile hybrids; but they, as well as the rest. help to tell the story of the past development, migration, and distribution of these snails.

I am greatly indebted to Mr. Charles Mosier, former custodian of the Royal Palm State Park, the great forest of which swarms with *Liguus*. Mr. Mosier made careful studies of these snails for years in this and many other hammocks in Florida and has freely given me the result of his observations.

The late Mr. John B. Henderson generously made it possible for me to visit the island of Haiti and to make a half dozen trips to various parts of Cuba, also to collect in places on the Florida Keys which were difficult of access. I am also under obligatons to Dr. Carlos de la Torre, of Habana, who allowed me to examine his great collection and make notes on it, also for many valuable specimens of Cuban *Liguus*.

This paper is respectfully dedicated to Charles Mosier, friend, master woodman, naturalist, and companion on many collecting trips, and to whose knowledge and assistance I am greatly indebted for much of what appears in these pages.

THE GENUS LIGUUS IN FLORIDA

The genus *Liguus* includes about a dozen species of large land snails inhabiting the northern and northwestern parts of South America, the island of Cuba, Haiti, Cozumel, off the eastern coast of Yucatan, and the more tropical part of Florida. The six species which inhabit the islands and Florida are brightly colored and strictly arboreal in habits, and they doubtless constitute a well-defined subgenus.

Cuba is an old island, geologically speaking, and has doubtless been inhabited by *Liguus* for a long time, possibly back into the Miocene. It is quite likely that the genus extended into Haiti at a time when the land was much more elevated than it is to-day and that island and Cuba were united.

Although Florida is separated from Cuba by a deep channel 90 miles wide it seems certain that it has derived all its *Liguus* stock from that island. At first one would naturally wonder how it was possible for these arboreal snails to cross such a body of ocean and become established on the new land. Both eggs and snails sink at once in water; no bird could possibly carry either across in its beak or on its body; neither could eggs or snails be transported through the air by hurricanes. The main current of the Gulf Stream which sweeps up past the western end of the great island turns to the west as it enters the Gulf of Mexico and slowly passes around its deep central basin. It is probable that under ordinary circumstances weeks would elapse before any floating object that passed into this great vortex through the Yucatan Channel would emerge and enter the Florida Strait, and in that time any *Liguus* which might be carried over this course attached to limbs or trunks of floating trees would be sure to be washed off and perish. It would seem, then, that every means of transportation for these snails was shut out and that it would be impossible for them to migrate in any way from the great island to Florida. But when we once fully understand all the conditions it appears as though nature had specially arranged everything not only to make this voyage and colonization possible but absolutely feasible and that there have been a considerable number of successful migrations and colonizations.

The *Liguus* never voluntarily leave the trees on which they live except at the time when they go down to lay their eggs or make the migrations across the country for the purpose of founding new colonies, which I shall later describe. During the dry season, from November to May, in Haiti, Cuba, and Florida, these snails throw out a gummy substance which hardens and attaches the shells so firmly to the trees on which they live that they will often break without letting go. At this period of aestivation, as it is called, the

animal becomes dormant, much as do those of northern countries during hibernation, only the organs do not so completely cease to function. Before the beginning of the rainy season, sometimes as early as April, the snails dissolve or let go from this epiphragm, as the gummy substance is called, and become active. Sometimes in winter if there is rain and especially if the weather is warm they do this but make an epiphragm and become dormant if it becomes dry and cool again.

They live, for the most part, on smooth trees, but sometimes they are found on those with rough bark, even live oaks, and in our State, only in its extreme lower part. Although almost wholly confined to the drier hammocks in Florida I have collected them in our brackish and fresh-water swamps, in the former on the tropical buttonwoods (*Conocarpus*) and on cypress trees in the latter. In very rare cases they have been seen on Caribbean pine trees at the edge of hammocks. Their food is the confervoid growth which is found on the bark and possibly the leaves of the trees which they inhabit. Sometimes, especially during rain, I have seen them clinging to the under surfaces of leaves though this was not for the purpose of keeping dry. During the warm season they freely copulate, and as they are hermaphrodites it is probable that nearly all the individuals become pregnant.

In the warm or rainy season from May till November tremendous showers fall in northern Cuba and trees in stream valleys bearing colonies of *Liguus* may be washed out and swiftly borne down on the current of the mountain torrents and into the sea. It is probable that most of our *Liguus* stock is derived from the northern slope of western Cuba, and such trees thrown into the ocean are caught by a small current that leaves the main stream which passes up the Yucatan Channel, and this smaller flow hugs close to the northwest shore of the great island. Farther on it joins the Gulf Stream after the latter has passed entirely around the deeper part of the Gulf of Mexico, the junction taking place in the Florida Strait, the whole great current moving to the east and northeast and sweeping against the lower part of Florida. This current in the strait moves onward ordinarily at the rate of from 2 to 4 miles an hour, much depending on the direction and force of the wind. In time of hurricanes with wind and heavy rain from the west or southwest the speed of this ocean river would be greatly accelerated, and trees bearing *Liguus* might easily be borne from northwest Cuba to the keys in 48 hours.

It is probable that some of the snails which adhere to the trees on which they live may be carried high and dry on limbs during a trip of considerable duration and distance as they are making this passage, but even if they do become immersed for quite a length of time I feel sure no damage would come to them. At one time I put a

lot of over 30 active *Liguus* into a vessel of water, weighting them down with a piece of board so that all were kept completely submerged for 30 consecutive hours, and when released every one of them crawled away as though nothing had happened. All were clinging to the board when they were taken out.

During the rainy season the wind in the Florida Strait blows for the most part from the southeast, and this drives any drifting material diagonally across the current toward the Florida Keys and the southeast mainland. A slight, irregular flow of water takes place along this part of the mainland and the keys in a direction opposite to that taken by the Gulf Stream. This slow movement keeps close in to the shore and would tend to carry drift to the south and west, even in some cases that which had passed for a considerable distance along the main current, thus helping to distribute material carrying *Liguus* along our southeastern shores. The greater part of the cold Labrador current goes under the Gulf Stream above Miami, and it is mixed up in this vicinity, so that it sometimes drifts to the north and again to the south. It is quite probable that the feeble current running westerly among the keys is the last vestige of this cold river.

Nearly all the inner shore line of the keys and the southeastern mainland of Florida is fringed with a growth of mangroves, but on the side fronting the open sea there are sandy or rocky beaches. The trees growing in "the mangrove" usually stand in mud or very shallow water; and wherever they grow conditions are not favorable for the landing of tree snails because, so far as I have been able to observe, they never crawl over wet mud. However, during September, October, and November we have unusually high tides all along our lower coast, then they sometimes reach an elevation of 2 or more feet above the ordinary tide. In many cases *Liguus* inhabit dead trees or limbs, and such might easily be broken up during their journey down the Cuban streams or while making the sea crossing before reaching Florida. I have no doubt that in some cases these snails reach our shores on comparatively small pieces of floating timber, and these could easily drift in among the mangrove roots, where they are not too crowded, during excessively high tides and be landed on what is ordinarily high and dry ground. If such a landing happens to be made in the edge of a hammock, the snails could crawl off and become denizens of the United States without any formality. Of course, during hurricanes the sea may be driven over the highest land on our lower coast, and it is most likely that the greater part of the *Liguus* have been landed and established in Florida during such storms. At one time, since I resided here, the wind during one of these storms drove the sea entirely over Elliotts and Largo Keys and far out on the mainland of Dade County.

There are authentic records of other even greater tidal waves in lower Florida.

Without a doubt this process of enforced migration began as soon as the *Liguus* spread over the island of Cuba, perhaps back in Miocene or Pliocene times, but it is probable that no region existed to the northward suitable for them to live in. Certainly if any colonies of these snails existed in any part of what is now Florida before the Glacial epoch they were destroyed by its cold, for they are tropical and can not stand hard freezing.

A period of subsidence occurred for the State of Florida during early or middle Pleistocene, and nearly all the eastern part of it and all the lower end to just north of the Caloosahatchee River were carried below sea level. A great bed of oolitic material, the Key West limestone, was deposited over the area now occupied by the Lower Keys. Another very similar set of beds was laid down along the southeast part of what is now the mainland—the Miami limestone—and a third on the southwest coast called the Lossmans River limestone. A set of beds was formed in what is now the Everglades, at first doubtless marine, then brackish, and finally fresh water. It is probable that a coral reef, which afterwards became the Upper Florida Keys began to develop during this subsidence, and it reached from a short distance south of Cape Florida in a curved line to what is now known as Newfound Harbor Keys, just south of Ramrod Key, thus lapping over onto what is now the Lower Keys for a distance of perhaps 5 miles. This was followed by an elevation during which the land was probably raised to about the same height as at present. The great bed of Key West limestone became a single island, reaching from east of Johnson Keys to and including Key West and from the Gulf of Mexico on the north to the Florida Strait on the south. The sea began to form a low, broad shore elevation just within what is now the southeast coast of the mainland from somewhere near Fort Lauderdale to the south, then southwest, west, and again southwest to near Whitewater Bay. This consisted of low ridges which formed one after another as the sea retreated, leaving flats and shallow lagoons between, and in these marine mollusks and other animals lived and died undisturbed. Later this became a soft oolitic limestone.

A great variety of seeds of tropical trees, shrubs, and plants was carried by the Gulf Stream, a few possibly by migrating birds, and some lighter ones by the wind and landed on the large southwest island as soon as it was high and dry above the tide, and at once a dense hammock growth was formed over much of the higher parts of it. Seeds of the Caribbean pine (*Pinus caribaea*) were probably blown across from Cuba and forests established on some of it and

on the rocky ridge of the lower mainland. Hammocks began to be developed in protected places on this ridge, and conditions were right for the establishment of colonies of *Liguus* on the soil of the United States.

We can not tell whether the first successful settlement of these snails was made on the great southwest key or southeast mainland, but quite likely on the former. A gravid specimen of a form close to our present *graphicus* clinging to the tree on which it had made its home was thrown up on this island, either by an unusually high tide or during a hurricane. It probably came from somewhere in the neighborhood of Cabanas, about 40 miles west of Habana, where Dr. Carlos de la Torre, the late John B. Henderson, George H. Clapp, and the writer found a form of *Liguus* in considerable numbers that has nearly all the characters of that beautiful snail. It is, however, smaller, is a richer yellow, is not quite so porcellanous, and is a little less flamed on the spire. I have little doubt that our *graphicus* sprang from the same stock as the small Cuban form did.

The newly arrived snail multiplied and probably spread over most of the drier parts of the island, for at least recognizable fragments of it has been found on most of the keys where there is high land. Certain forms among its progeny seem to have partially lost their coloring, and one of these which Say called *solidus* has a broad, faint, spiral yellowish band above the periphery and another on the base. A second somewhat thin variety which has delicate coloring Pilsbry has named *solidulus*. This is whitish or cream colored with one or two faint yellowish narrow, spiral lines at the periphery, another at the suture, and sometimes a broad one on the base. Some of the shells which are doubtless of this variety have two or more narrow greenish or bronzy spiral lines on the last whorl, and others scarcely show a trace of banding. A shell from Ramrod Key of the lower islands is almost pure white throughout, and a very solid form which I found on Big Pine Key is ivory white, with a single narrow, bronzy peripheral line and a decidedly truncated columella to which I gave the subspecific name of *crassus*. Mr. John B. Henderson had specimens in his collection from Key West which I refer to this. I feel sure that if a large collection of *solidus* could have been made from the Lower Keys it would have shown a considerable amount of variation in coloring.

Reeve bestowed the name *Achatina picta* on a form of *solidus* which has a pale, ashy yellow ground pattern with longitudinal bluish smears and a double row of squarish brown spots at the periphery and sutures, and he gave Cuba as a locality for his shell. There is a specimen in the collection of the United States National Museum with the same locality given, and many years ago I re-

ceived a fine shell of this form in an exchange from A. G. Wetherby labeled "*Achatina fasciata*, Cuba." I only know of two authentic Floridian specimens of this subspecies, one of which is in the collection of the Academy of Natural Sciences of Philadelphia and was collected by Dr. H. A. Pilsbry on Big Pine Key when on a trip to the Lower Keys with the writer in 1907. The other is a somewhat worn shell, but showing the colors perfectly, that I found on the same island in the village of Big Pine a few years later. D'Orbigny figures a shell in his Atlas which he credits to Cuba and which no doubt came from that island which bears some resemblance to *pictus*, but it is not that. I found a very similar shell at Luis Lazo in western Cuba that I believe is a hybrid between some form of *fasciatus* and *solidus*.

It seems a little strange that this snail (*pictus*) should be reported from Cuba at least three times if it was never found there. I am very much inclined to think that it has actually been collected in that island as well as in Florida and that it crossed the strait and landed on Big Pine Key since the dismemberment of the large island, and so short a time ago that it has not changed any of its characters in the least. There is comparatively deep and open water close up to the big hammock in which both the specimens of *pictus* were found on this island.

It is probable that not more than two forms of *Liguus* ever landed on the great island, although it is nearer to Cuba than any other part of Florida, and it certainly was clothed with hammock at an early date. The reason for this paucity is perhaps the fact that the Lower Keys lie almost directly across the Florida Strait from the western part of Cuba, and the strong eastward-flowing Gulf Stream would naturally carry any drifting material past them.

No sooner was the great western island, the original of the present Lower Keys, formed than the forces of nature began to destroy it. Every winter several storms called "northers" sweep down from the northwest across the Gulf of Mexico, the wind often blowing to 30 or even 50 miles an hour, throwing the water of this great inland sea with tremendous force against the land of this region and cutting into it all along its entire northern exposure. As a consequence its northern outline is far more ragged than the southern. Not only this but the water was driven with such force that it was crowded completely through the porous foundation of the island from north-northwest to south southeast so that it came out in strong streams on the south side into the Florida Strait. This water soon formed channels through the loosely compacted rock in the eastern part of the great island, and these were enlarged by scouring and the action of the carbon dioxide in it. Later the weakened roofs fell in so that open streams reached entirely across, for the most part in exactly the

direction of the wind during these storms. It is probable that the rock in the western end of this former island is of a solider type than that of its eastern part, hence the water was not driven through to any considerable extent but it entered everywhere by seepage and has eroded and dissolved it into a most complicated archipelago. I feel certain that a *Liguus*, the forerunner of the forms we have found on these Lower Keys, reached the big island, became established, and spread over the entire region and that it broke up into several varieties which pretty well occupied the whole area before the dismemberment took place.

A thin, glassy, inflated form of *crenatus* was cast ashore on the elevated hammock near Fort Lauderdale, no doubt an early migrant from Cuba to our shores. Later the sea threw up a great sandy bar or bank a few miles to the east of this forest, and the intervening space has been filled with a mangrove swamp. The *Liguus* has been carried down and established on this bank where I found it at the New River mouth and for a couple of miles to the northward. This colony of *septentrionalis*, as Pilsbry has aptly called it, is the farthest north of any in the United States. The form has spread south of New River, it has crossed Little River, and in a hammock just below the mouth of that stream I found nearly pure individuals. Near Arch Creek it has hybridized with one of the forms of *fasciatus*, the shells having exactly the shape, markings, and texture of *septentrionalis* but a pink axial region. I have shells from the town of Jamaica in Cuba that are very close to this.

It is probable that at least four forms of *Liguus* that drifted from Cuba became established at the great Miami hammock. According to the Report of the State Geological Survey some of this land is elevated to a height of 30 feet above sea level, and it is most likely the highest on the southeast coast. It was probably above the sea and was dry land before any other part of this general region and has had a longer time in which it could be colonized by snails. These forms I have called *miamiensis*, *livingstoni*, *mosieri*, and *eburneus*, the first two belonging to *fasciatus*, the latter two to *crenatus*, and none of them inhabits the Upper Keys. *L. miamiensis* is doubtless a hybrid between a form near *castaneozonatus* and probably a typical *fasciatus*, the earlier whorls having a broad, more or less broken brown band and the last whorl a pattern of spiral lines, the two coming together abruptly. I have shells from Cuba which show similar characters. This form ranges from Ojus to a considerable distance south of Miami. The form *livingstoni* is a small *fasciatus* usually lacking the color pattern on the upper spire, but I have a shell from Luis Lazo, in Pinar del Rio, that is exceedingly close to it in which the color pattern has almost vanished. It is found from Fort Lauderdale south to Long Pine Key. I have large shells of *mosieri*

from Miami that are almost identical with a specimen from Mount Guajaibon in northwestern Cuba, they being larger than the latter. It is found over nearly the entire rocky ridge of southeast Florida. *Eburneus* is a fine subspecies usually large and solid, somewhat porcellanous, and nearly always pure white throughout. It is almost perfectly mimicked by a shell I collected in western Cuba. It does not extend north of the Miami River but goes south to Long Pine Key in the Everglades.

Thirteen subspecies of *Liguus* inhabit this great Miami hammock—*eburneus*, *mosieri*, *luteus*, *cingulatus*, *marmoratus*, *livingstoni*, *ornatus*, *miamiensis*, *elegans*, *roseatus*, *testudineus*, *castaneus*, and *castaneozonatus*—a considerably greater variety than is found in any other Floridian locality. *Luteus* occurs from Dania to Long Pine Key and in the former region as well as at Vaca is rather solid and bright colored, but in the lower Dade is thinner and lighter. It is the first form to be colonized in the incipient hammocks, and at almost every sink that has a live oak and a little scrub it will be found, while *castaneozonatus* is the second migrant. *Marmoratus* is a very variable snail with a wide distribution, and specimens found by me in the Miami hammock are very close to those from Key Vaca of Chokoloskee. A form of this has recently been found at Pinecrest, 35 miles west of Miami in the Everglades. I have no doubt but that *testudineus*, *castaneus*, and *versicolor* are hybrids between this and forms of *fasciatus*. The subspecies *elegans* was discovered on a small key in the southern Everglades, which was occupied exclusively by it and *roseatus*, and it is close to shells I collected in northwestern Cuba. It occurs occasionally along the rock ridge as far north as Arch Creek, usually in a pure form and always having the peculiar brownish flecks on the upper spire.

Two peculiar forms of *crenatus* are confined to the southwest mainland, where they have a limited distribution—*lossmanicus* and *capensis*. The former is dull colored, whitish, sometimes with narrow spiral greenish lines, and the whorls are usually well rounded. The form *capensis* is elongated, and solid with flattened whorls occupying Northwest Cape exclusively and found rarely elsewhere in the cape region. It is probable that both are recent arrivals from Cuba, and they may have drifted through the Bahia Honda Channel. The fact of their limited distribution is evidence in the direction of their recent arrival.

It is probable that the land of the Cape Sable region is very recent, one of the latest additions to our territory. The area covered by the three points, Northwest, Middle, and East Capes, and the region for some distance back of them is sandy, but it was built up over an old mangrove swamp. Back of this sandy land there is a brackish swamp, and still farther back a considerable prairie, while at the

juncture of the two latter is a line of hammocks. The entire inner country lies only just above high tide, and whenever during a hurricane the wind becomes westerly the water from the Gulf of Mexico is driven in to Florida Bay and the region to the north of Sable with great force. As the chain of Florida Keys acts as a barrier against this water passing to the eastward it is dammed up and forced over the south shore, the Sable and southwest coast areas, sometimes covering the highest land to a depth of several feet. Before there were any breaks in this upper chain of islands the dam was almost complete, and doubtless the depth of water became much deeper than at present. As there is a great deal of swamp in this territory, *Liguus* can not progress from hammock to hammock as they do through the high pine woods for, as I have said, they never crawl over wet mud. There are, however, both *Liguus* and *Oxystyla* distributed abundantly throughout this whole area wherever there are suitable hammocks, but they are scattered absolutely hit and miss. At Northwest Cape only *capensis* is found, while in a little hammock just north of Middle Cape Dr. Edward Mercer and I got *lossmanicus*, *castaneozonatus*, with hybrids between the two, and a single, fine *marmoratus*. At Middle and East Capes there is quite a variety of forms, and this is true of the line of hammocks between the prairie and the brackish swamp. In one of these would be found an *Oxystyla*, in the next perhaps a single form of *Liguus*, in a third absolutely nothing, and in the next both *Liguus* and *Oxystyla*. Yet in some cases these bits of woods are only a few rods apart. The explanation of this is, I believe, that trees and limbs with snails are torn off by the fury of the hurricanes in this region, probably carried along by the high water and landed on some hammock. One such piece of forest might receive a *Liguus*, another an *Oxystyla*, another both, and a fourth none. The ground immediately in front of this row of hammocks is always swampy; that in the rear is wet in the rainy season and dry in the cool part of the year. The snails can not crawl over it in summer, and in winter they are fast to the trees. Some of the cape forms may have arrived during the first elevation, but most came at the second.

Since the above was written a great highway, the Tamiami Trail, has been opened from Miami west through the Everglades, and at a place on this called Pinecrest, midway across the State and 40 miles from its south end, Mr. Joseph Farnham and Mr. Richard Deckert have found great numbers of *Liguus*. Many of these are hybrids, but they are generally rather closely related to the forms found on Long Pine Key in the south part of the Glades. It is probable that during one of the late minor subsidences this region was somewhat lower than now and that a strong tidal wave may have carried the

progenitors of these forms from Long Pine Key and landed them here.

It is probable that at the time of the first elevation the reef of which the Upper Keys was formed was considerably developed and raised to the surface of the sea or even somewhat above it in places, but I doubt if it was clothed with hammock forest or inhabited by land snails. The flora is composed of tropical plants and has been almost wholly derived from Cuba, but it is comparatively poor, having scarcely half as many such species as the Lower Keys and nothing like as many as the southeast mainland, and this fact would prove that it is much younger than either of the last-mentioned areas.

Then there was a second period of subsidence during which the land went down until the sea washed into the present bluffs at Coconut Grove and Miami, eroding them in places into fantastic forms. At Little River the depression amounted to some 7 feet, while at Big Pine Key it was about 3 feet.

An elevation followed during which the land was raised perhaps to a few feet higher than it is at present. The Upper Keys were elevated until they probably formed an unbroken chain or single island. The sea attacked the reef, tearing it to pieces, scattering the fragments and grinding them into sand, then cementing the wreck firmly together and building it up into a solid, continuous island. This great barrier for a long time prevented floating material from landing on the mainland back of it, but it became more or less covered with hammock forest and provided a home for such *Liguus* as drifted in from Cuba. Several forms, either *roseatus*, *castaneozonatus*, *vacaensis*, *lineolatus*, and perhaps *marmoratus* or their immediate progenitors, drifted in from Cuba and became established long enough ago that they spread practically throughout the entire length of the long, curving island. This was the heyday of the Upper Keys, the period of their greatest development and glory. A broad, irregular land bridge reached from the region of the Matecumbes across to the mainland from Joe Kemps Key for 12 or 15 miles to the eastward. In places this was swamp or shallow lagoon, but there was continuous hammock-covered land, and over this migrated a considerable variety of tropical vegetation from the keys; in fact most of the flora of the south and southwest coasts of the mainland was derived from the Upper Keys in this way. This flora differs considerably from that of the rocky ridge along the southeastern mainland. It is nearly all tropical, while that of the ridge is mixed—West Indian and warm temperate—the latter part being derived from the northward. The reason for this is that the Everglades stretches, and since the first elevation has stretched, in a broad, unbroken area from near Whitewater Bay eastward and northeastward to Cutler, forming an effectual barrier against the

passage of dry-land plants and to a considerable extent the migration of snails. *Liguus* could only cross this great marsh during a time when the sea was driven in over it by hurricanes and then on floating timber.

During the time of the second elevation there was probably an almost continuous hammock along much of the south shore of the mainland; in fact a considerable amount still remains. The *Liguus castaneozonatus*, *vacaensis*, *lineolatus*, *roseatus*, and *marmoratus* crossed over from the keys and became established on the south and southwest parts of the mainland. By and by the sea began to seriously gnaw away at the great coral island. High tides occur on one side at different times from what they do on the other, and I have seen at low tide on one side of one of these coral keys many streams of water passing through, from a tiny trickle to those of the size of small rivers. Soon the carbon dioxide in the water ate the rock away until the weakened roof fell and later an open channel formed which cut the island in two. This action, aided by the fury of the sea when driven in by storms, has been continued until this once greatly elongated island has been cut into more than 30 islets and islands, each high enough to bear upland hammock, besides a vast number that are only clothed with mangroves. Of course when a key was cut in two it checked the passage of the *Liguus* from one island to the other, and we can form some idea of the time of arrival of the snails by their distribution. The subspecies *matecumbiensis* did not arrive until Upper Matecumbe was cut off from the keys to the north and south of it, for we have never found it on any other of these islands. But it came in time to cross the land bridge, for we find it one of the most abundant of the tree snails of the Flamingo region. *Oxystyla floridensis*, which inhabits the keys from Largo southwestward, crossed this bridge and is very abundant in the Cape Sable area; but *O. reses*, which inhabits the keys from Key West to Vaca, apparently has not passed any farther up them nor crossed to the mainland. A beautiful form, *subcrenatus*, was common in the center of the upper chain from probably Largo to Grassy Keys. The subspecies *elliottensis* has its metropolis on the island for which it is named but has been found on Old Rhodes and possibly upper Largo. It was a late arrival and probably was kept from an extensive distribution because of the cross-channels.

Four subspecies of *Liguus* which inhabit almost the entire range of the Upper Keys—*castaneozonatus*, *roseatus*, *marmoratus*, and *luteus*—are also found on the mainland on the rocky southeastern ridge, although a tract of Everglades and a series of shallow sounds separate the two regions. During time of hurricanes when the sea is driven against southeast Florida with tremendous force the entire chain of islands may be overflowed and water driven in until it covers

the lower parts of the rocky mainland ridge. At such times many limbs and trees on these keys are torn off or uprooted and with their load of *Liguus* may be easily carried across and landed on the higher mainland. There it is easy for the snails to crawl off and get into the hammocks, where they are soon established.

The last general earth movement in lower Florida was a slight subsidence which may be continuing yet in places and of which there is abundant and widespread evidence. In the Shark River region hundreds of acres of what must have been land are to-day under a very shallow sheet of water in which littoral forest grows thickly and in the same general area and in Biscayne Bay are dead trunks of large mangroves that probably started growth on the land, but have been killed by the slight subsidence. The marly hammocks along the south coast are tumbling into the sea and the general chain of keys is being rapidly destroyed by the encroaching ocean. The great land bridge has been reduced to low islets and shoals. This subsistence has had a marked effect on the *Liguus* of the upper islands.

The distribution of the *Liguus* on the Upper Keys is amazing, and for a long time I was utterly unable to understand how it came about. Seven subspecies—*castaneozonatus*, *roseatus*, *lineolatus*, *vacaensis*, *marmoratus*, *luteus*, and *subcrenatus*—are found living on the upper and lower ends of the chain but all save *lineolatus* and *subcrenatus* are entirely absent from the central part of it. The subspecies *subcrenatus* now inhabits Lower Matecumbe and has probably lived in the islands to the southwest as far as Grassy, perhaps to Vaca, while *castaneozonatus* and *luteus* occupy the northern end of Upper Matecumbe and the islands to the northwest. Long Key, farther down in the chain though a large island with some dry, hammock-covered land, seems to be absolutely lacking in *Liguus*. Yet on Lower Matecumbe, Lignumvitae, the extreme lower end of Upper Matecumbe and Indian Key, lying in the exact region where five of the forms I have mentioned are absent, we find no less than four tolerably well-defined subspecies of *solidus*, a species only found elsewhere in the United States on the Lower Keys. Why are these seven forms present in the ends of the chain and all but two absent from the center, and why should they be replaced here by a species of the lower islands? Why is Long Key without *Liguus* when it seems to be perfectly adapted for their growth?

I feel sure that during the period of greatest elevation the entire set of the Upper Keys from near Cape Florida to and including the Vaca group was one great island, so high and well clothed with hammock that the seven forms I have mentioned, which were early arrivals, became distributed throughout the whole. Then at the time of the last general subsidence the middle of this chain went down just

enough to change the dry-land hammock into mangrove swamp, and it needed only a slight depression to do this. Five of the forms—*castaneozonatus*, *roseatus*, *luteus*, *marmoratus*, and *vacaensis*—were drowned out on Lower Matecumbe, but *subcrenatus* and *lineolatus* survived, probably on a bit of hammock at the upper end of the island, as this is a little higher than the rest of it. The snails were drowned on the southwest end of Upper Matecumbe, which is slightly lower than its northeastern part and is now nearly all swamp with only here and there dry land. Long Key was carried down just enough to drown out its *Liguus*. It is probable that a very slight upward oscillation of this region since has made the latter island dry enough for high hammock growth as a foot of elevation would change swamp to dry land. But no *Liguus* have landed on it since.

During this last slight elevation of the mid chain a gravid specimen of the variety *graphicus* was landed (on drift from one of the Lower Keys), probably on Lower Matecumbe, where it quickly became established and soon began to vary. Two of its forms, *lignumvitae* and *simpsoni* are now living on the near-by Lignumvitae Key, a mere dot of land just inside the regular line of the chain and separated from Lower Matecumbe by a mud flat a little more than a half mile wide. Another form which I have called *delicatus* is found on Lower Matecumbe and on a small bit of hammock in the swamp of the lower end of the upper island; also it was found by Wurdemann long ago on Indian Key, another mere point about half a mile outside the line of the regular chain and just off the lower key. I am inclined to believe that these outlying *Liguus* reached Lignumvitae, Upper Matecumbe, and Indian Keys by drifting during storms.

In a part of Lower Matecumbe, where cross currents have eroded and lowered the surface until it is no longer dry land, there is a small hammock in which I found a fourth form of *solidus*. The shells are large, thin, of a glassy rather than porcellanous texture, the ground color being a pale yellowish gray. They have the longitudinal smears and a brownish peripheral band, and along this and the sutures is a double row of squarish spots, while the entire axial region is white. Because of its resemblance to *pictus* I have called it *pseudopictus*. Apparently it has rather recently developed in this isolated hammock, and I found a few partly intermediate shells. I have no doubt that it is the latest form of the genus to develop in Florida.

The species *solidus* seems to vary very easily and apparently has broken into many forms. I found several interesting variations or perhaps hybrids of what may be this species and some other near Cabanas, Cuba, and I feel sure that before our hammocks were destroyed in Florida there were several variations. I found shells on

Lignumvitae Key which are so close to *graphicus* that it would puzzle an expert to tell them apart, but there were intermediates between them and *lignumvitae*. While the porcellanous structure is one of the chief characters of what we call *solidus*, it is almost absent in *pseudopictus*, and the axial region in the species may vary from almost dark purple to pure white.

It may seem that I have recorded a large number of minor elevations and depressions, mere oscillations, in lower Florida since the first appearance of the land, and I feel sure that there have been, as for most of them there is still in existence evidence in the form of raised beaches, eroded bluffs, or sunken forests. Samuel Sanford corroborates this statement and says that in places they have been rapid enough to be proved by human records.[1]

Almost all of lower Florida is very flat, and it rises but slightly above sea level. The same authority I have just quoted remarks, on page 189 of this second report, that "A difference of 2 feet in water level means the difference between shallow lake and dry land for hundreds of square miles." So also in the immediate vicinity of the sea a subsidence of less than a foot might mean mangrove swamp and a corresponding elevation land covered with *Liguus-bearing* hammock.

But the vertical movements were only slight from the first appearance of land in this region until now. At no time has there been a subsidence so great that the large lower island or the rocky mainland has been drowned out nor an elevation sufficient to make dry land of the bays along the southeast coast of the mainland, for in that case the warm temperate flora of the rocky ridge would have crossed over to the Upper Keys, and had there been a drown out the distribution of our plants and *Liguus* would have been very different now from what they are. Since the first great Pleistocene elevation I do not believe that the change of level has amounted to 15 feet.

The colonization of *Liguus* on the mainland of Florida came about under quite different circumstances from those of Cuba or most of our keys. In both of the latter areas there was a practically continuous growth of tropical forest which was exactly fitted for a home for these snails. They are hermaphrodites, and during their period of activity it is probable that most of them copulate and become gravid. At this time a considerable number of individuals come down from the trees on which they make their homes, and instead of depositing their eggs in the ground near them they obey a call to form a new colony. They travel directly away, probably going in a reasonably straight direction, and whenever they are satisfied they stop, dig out a shallow excavation among the leaves and trash, lay their eggs, cover them, and find a near-by tree for a new home. There is no

[1] Second Report Florida Geological Survey, p. 180.

special risk or hardship about this, for the snail never leaves the sheltering hammock; it can stop and deposit eggs whenever it likes; there is an abundance of food all around it.

A large part of the lower Florida mainland, however, is covered with an open growth of Caribbean pines, and such a region is hostile to the *Liguus*. There is practically no shelter; there is little or no food; in places where the floor of the forest is sandy it is impossible for them to progress unless they can crawl from plant to plant above it. Only here and there at intervals is there a hammock, and although the snails have a certain amount of vision yet it is probably impossible for them to distinguish one from the pineland. Yet these wanderers obey the instinct for founding colonies which was begotten during the thousands of generations that preceeded them and boldly strike out into the pine woods in order that they may reach another hammock and plant their race in a new territory.

At my home I once observed one of these snails which had doubtless left my near-by hammock and was attempting to work its way out into the open pine woods. We had rains for several days in succession, and during this time it moved away from the hammock at the rate of about 25 feet a day, and I kept close watch and set stakes to mark its onward passage. This one and others I have noticed crawled along the stems of small shrubs or grass, over fallen logs, or anything that made a firm pathway. When the weather was dry and the sun shone the *Liguus* attached itself to something and did not attempt to go on until it rained again. I kept track of this specimen for several days, noting that it persistently worked away from my hammock and out into the uncharted pine woods. I have on a few occasions found them in the open forest at a long distance from any hammock and in rather numerous cases the dead shells which probably testified to the disaster in the way of exhaustion that finally overtook them.

The migration is of course absolutely hit and miss, as no snail can know when it starts on such a journey that a hammock is in front of it. No doubt in cases where a number of hammocks are scattered through an area of pine forest a crawling *Liguus* might pass by one and, continuing on, enter another not far away. So in any general region a hammock may have a form that is absent from another that is only a few rods away; one may have several subspecies and another near by only two or three, even a single one, or rarely none at all. One of our leading botanists believes that the hammocks formerly covered most of the lower part of Florida and that the pine trees are late immigrants that are spreading and taking possession of the country, but if this were true we should find the remaining hammock portion occupied by practically the same forms of *Liguus* throughout.

There is another way by which, to a limited extent, it is probable that the *Liguus* may pass from one hammock to another and become established. Mr. Charles Mosier informs me that he has on several occasions seen crows flying with these snails in their beaks. It is a

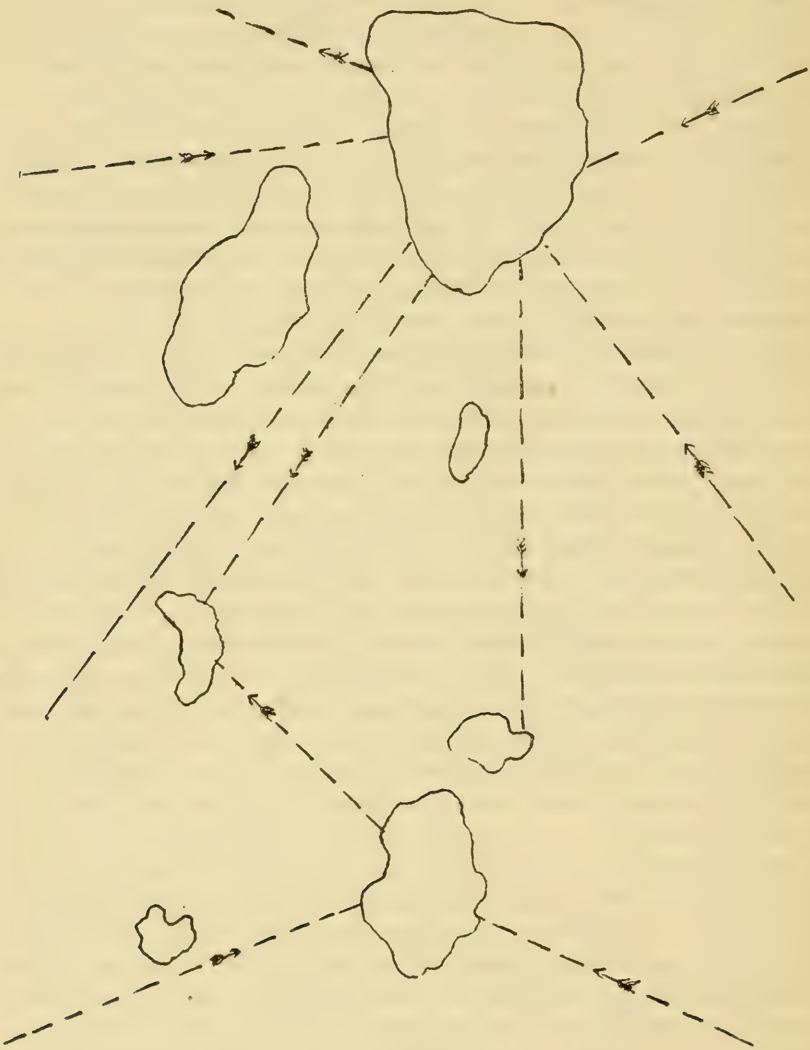


FIG. 1.—DIAGRAM ILLUSTRATING THE DISTRIBUTION AND MIGRATION OF LIGUUS IN FLORIDA. THE OPEN SPACES ARE PINE WOODS; THOSE INCLOSED IN LINES, HAMMOCKS. DOTTED LINES SHOW MIGRATION TO AND FROM HAMMOCKS. SOME BITS OF FOREST ARE REACHED BY SEVERAL; OTHERS ARE ENTIRELY MISSED

well-known fact that these and other large birds frequently prey on *Liguus* and other arboreal snails, and I have seen the ground in hammocks strewed with their broken shells. It is not unlikely that these birds may occasionally pick from a tree one of these snails and

carry it away with it, just as they carry away large seeds. The *Liguus* when disturbed throw out a quantity of a mucilaginous substance which is very slippery, and in such a case it might easily happen that the snail would slip and fall to the ground during the flight of the bird. If it should fall in a hammock in an uninjured condition there would be nothing to hinder it from making its home there, and if gravid laying its eggs and establishing a colony. Such distribution would be essentially the same as if the snails crawled through the pine forest.

As the changes of land level and the movements of the *Liguus* have been somewhat complicated I will briefly recapitulate. These snails in Cuba are closely related to our forms and without a doubt are their ancestors, often scarcely removed varietally. I am sure that the close resemblance of a number of forms from the great island to those of our State are not accidental but that they indicate very close relationship. I have actually seen snails there that are very much like *graphicus*, *livingstoni*, *miamiensis*, *septentrionalis*, *elegans*, *subcrenatus*, *eburneus*, *castaneozonatus*, and *mosieri*, and I have no doubt that there are other contiguous forms.

Trees in which these Cuban snails grew were washed out, carried with their living loads down the torrents into the sea and swept by current or the force of hurricanes along the Florida Strait; the southeast winds of that region would bear them on to our lower shores where, because of hurricane tidal waves or very high autumn tides, they would be landed high and dry on our shores where they could form colonies.

There was a great subsidence of Florida during early or mid-Pleistocene time, and the region now occupied by our Lower Keys and the southeastern part of our mainland received a deposit of oolitic limy beds. A long, curving coral reef began to grow along the south and southeast part of the State from near Cape Florida to the south side of Ramrod Key. During the elevation that followed, the sea swept this oolitic material up along our southeast coast and formed a series of low ridges as the shore retreated and when this land was high enough it became covered with Caribbean pines whose seeds were wind blown from Cuba. A single great island was raised covering the area of the present Lower Keys and seeds from west Cuba, for the most part, were borne in on the Gulf Stream and the large island partly planted with hammock growth. Two large hammocks were formed on what was then the open coast, one at Fort Lauderdale, the other at Miami.

A gravid snail much like our *Liguus solidus graphicus* drifted in from near Cabanas, Cuba, was landed on the lower island and became established in the hammock, spreading over the greater part of the area and breaking into several varieties before the land was

cut up into islets. One form of *crenatus* landed at Lauderdale and spread southward; several came to the great Miami forest and, as the land was raised and developed, hammocks spread southward and southwestward along the low, rocky ridge. It is doubtful whether the reef became high enough for hammock and snails to develop on it at this time, but the sea no doubt attacked and spread it.

During a subsidence following, the coral reef probably grew up as fast as the land went down. The water of the Gulf of Mexico driven by furious northers began to erode the north shore of the great island and was driven in places entirely through it, finally cutting up a considerable part of it into islands running exactly in the direction of the wind. Sea water entered what was probably solider rock at the west end and ate it into a complicated archipelago. *Liguus solidus pictus*, found only on Big Pine Key, is perhaps a recent arrivel coming long after the great island was dismembered.

When the land was elevated again it reached a higher level than now, and as it rose the sea kept tearing at the reef and consolidating it until at the time of highest land it was no doubt a single long curving island with continuous hammock and a number of *Liguus* which came from Cuba were thrown on it and had time to spread throughout its length. At this time there was a broad land bridge across from the Matacumbes to the south mainland. The flora of the Upper Keys is tropical but meager in species, and this would prove that the chain was much younger than the southeast mainland or the Lower Keys, which have a far richer tropical flora.

Many species of these West Indian plants crossed on the continuous hammock of the old bridge and now constitute almost the entire flora of the south shore and southwest coast. Through this hammock *Liguus marmoratus*, *vacaensis*, *roseatus*, *lineolatus*, *castaneozonatus*, and no doubt *Oxystyla floridensis* crossed to the mainland and became established there, perhaps during the time when there was the highest land elevation. *Matecumbiensis* landed on the key it was named for after the dismemberment of the Upper Keys but before the destruction of the bridge, and crossed. Dry-land connection between the south shore and the rocky ridge was prevented by the Everglades which stretched from Cutler to Whitewater Bay and had done so from the first. Several forms belonging to the Upper Keys were carried to the southeastern mainland across the bays by hurricane agency. The Cape Sable region is very recent, the capes being sand washed up on an old mangrove swamp. The sea is thrown in upon that region by hurricanes with terrific force, and as the water is driven into Florida Bay and is prevented from flowing south by the keys it overflows the Sable and southern shore regions and *Liguus* and *Oxystyles* are distributed hit and miss.

Capensis and *lossmanicus* may be recent arrivals through the Bahia Honda Channel.

Seven subspecies of *Liguus* inhabit both upper and lower ends of the upper chain of keys but all save *subcrenatus and lineolatus* are totally missing in the center of the chain, and they are replaced by forms of *solidus*, which appear to have developed from *graphicus*. Long Key, which has good hammock, seems to have no *Liguus*. During the last general subsidence the Upper Keys went down enough that all the *Liguus* in the center of the chain save *subcrenatus* and *lineolatus* were drowned out, and these subspecies probably survived on a bit of dry land at the northeast and higher end of Lower Matecumbe. All the snails of Long Key were drowned and no others have reached it since. During a local but slight elevation of the center of these keys a gravid *graphicus* landed on the first-named island, where it multiplied and broke into variations, some of which drifted to some of the near-by islets.

In Cuba and the Florida Keys the *Liguus* have for ages occasionally come down from the trees when gravid and, obeying an instinct for founding new colonies, have wandered off into the forest, stopping and making a slight excavation where they lay their eggs and fulfill their mission. But in the southeastern part of our State the hammocks are scattered throughout the pineland, which is hostile to the snails. However, they obey this call that has been inherited from thousands of generations that have lived under different environment and strike out into the pine woods in search of hammocks. No doubt most of them miss finding a hammock and perish; others find one and create a colony which continues the race in a different locality.

Although there have been several oscillations since the great subsidence of early or middle Pleistocene, yet they have been but slight and in all were never great enough to drown out the snails or highland vegetation on the greatest elevations or to make dry land of the bays on the southeast coast of our State.

Notwithstanding the fact that all that I have narrated has taken place since early Pleistocene, the briefest bit of geological time, yet I feel sure that long ages were required for the development of lower Florida and to people it with *Liguus*. There was much migration, much hybridizing, the development of new forms, and time was needed for them to adapt themselves to their environment. The whole must have taken many thousands of years.

The death knell of these beautiful snails in Florida has been sounded, and it will be but a few years until all are gone, save it may be in the great Royal palm hammock which is a State reservation. Most of the small hammocks have been destroyed, and in others still standing the snails are fading away before man. In my

bit of forest, into which I have carried many specimens from elsewhere, the birds have attacked them, and now scarcely one remains.

I do not believe that it is possible to make a key that will enable anyone to identify all the material in any considerable collection of Floridian *Liguus*. Without a doubt most of the forms of *fasciatus* and *crenatus* freely hybridize under favorable conditions, with the result that there will be found a certain number of nondescripts that can not be placed anywhere, while some that are of purer strain vary so greatly that it is difficult to classify them. Still I believe that by far the greater part of our material may be referred to some of the names in this descriptive list.

Many of the specimens in our collections have been killed in boiling water, which causes some of the colors of the shell to fade or otherwise change considerably. Under such treatment green is almost certain to become bronzy or dirty grayish. In some cases green lines become abraded even during the life of the animal, or they may change color.

The shells of *solidus* and its varieties are usually decidedly porcellanous and brilliantly polished, while those of the other two species are less so, but *pseudopictus* is comparatively glassy in some cases but lacking this soft, translucent texture, and on the other hand *eburneus* is occasionally quite porcellanous.

KEY TO THE FLORIDA LIGUUS

Apex, columellar region or both, pink, purplish, or violet.
- Shell decidedly porcellanous.
  - Bluish or purplish axial smears present, never reduced to a mere line.
    - Shell rather thin.
      - With a double sutural and peripheral row of brown spots__**pictus.**
      - Without a double sutural and peripheral row of brown spots.
        - With a brown peripheral and green spiral line or band. **lignumvitae.**
    - Shell solid (green spiral lines absent)________________**graphicus.**
  - Bluish or purplish axial smears absent or if present reduced to a mere line.
      - Peripheral white zone with a central brown line______**delicatus.**
      - Peripheral white zone without a central brown line___**simpsoni.**
- Shell not porcellanous.
  - Shell white, with broad supraperipheral and basal spiral bands.
    - Spiral bands yellow or orange__________________________**roseatus.**
    - Spiral bands not yellow or orange.
      - Spiral bands chestnut ______________________**castaneozonatus.**
      - Spiral bands not chestnut.
        - Spiral bands broken into alternate light and dark axial streaks_ ________________________________**alternatus.**
  - Shell white, greenish, or smoky white, with few to many green spiral lines which are absent on the periphery________________**livingstoni.**

Shell not white.
Shell flesh colored or pinkish.
With a reddish peripheral line and a few brown spots on the upper spire -- elegans.
Without a reddish peripheral line and a few brown spots on the upper spire.
A few dark spiral lines may be present or absent - lineolatus.
Shell not flesh colored or pinkish.
Shell pale yellow to orange, or orange brown (usually with a few dark spiral lines) ------------------------------ ornatus.
Shell not pale yellow to orange, or orange brown.
Shell dark, irregularly marked with green.
Dark spiral lines conspicuous on last whorl. testudineus.
Dark spiral lines not conspicuous but absent or only faintly indicated.
Shell with axial yellowish flames ------ castaneus.
Shell without axial yellowish flames.
Shell variegated, brown, smoky yellow, or bluish ------------------------ versicolor.

Apex, columellar region, or both not pink, purplish, or violet.
Shell entirely white.
Shell porcellanous.
Ground color ivory white with or without a dark peripheral line. crassus.
Ground color not ivory white with or without a dark peripheral line.
Ground color white, cream, or straw colored.
Shell with a broad basal and supraperipheral pale yellow band. solidus.
Shell without a broad basal and supraperipheral pale yellow band.
Shell with two narrow yellow peripheral bands and one at the suture ----------------------------------- solidulus.
Shell not especially porcellanous.
Shell of pure white, ivory white, or whitish ground color.
Spiral lines greenish or bronzy.
Whorls well rounded.
Whorls slightly shouldered at summit ----------- vacaensis.
Whorls not slightly shouldered at summit.
Whorls short and subsolid, dull colored (often with a ledge within its aperture) ------------- lossmanicus.
Whorls not short or dull colored (last whorl often bronzy or greenish) ---------------------- mosieri.
Whorls but slightly rounded.
Shell with the columella curved ---------- matecumbiensis.
Shell with the columella not curved.
Shell solid ----------------------------------- capensis.
Shell not solid.
Shell thin.
Shoulder generally angulated (not small). septentrionalis.
Shoulder not generally angulated (small). elliottensis.

Spiral lines not greenish or bronzy.
Spiral lines broad, yellow------------------------**cingulatus.**
Spiral lines not yellow.
Spiral lines reduced to mere indication of dark lines on base--**eburneus.**
Shell not of pure white, ivory white, or whitish ground color.
Ground color yellow to orange or greenish yellow or ashy.
Double row of brown spots present at the suture--**pseudopictus.**
Double row of brown spots not present at the suture----**luteus.**
Ground color not yellow to orange or greenish yellow or ashy.
Ground color dark with yellowish axial markins---**marmoratus.**

DESCRIPTION OF GENERA AND SPECIES

Genus LIGUUS Montfort

All material referred to which was obtained by others or which has been seen in other collections is duly credited; the rest was collected by the author. I have not given synonymy partly because I do not have access to the necessary literature.

Shell imperforate, oblong to ovate-conic, with simple, usually thin, unexpanded lip and obtuse, vertically wrinkled or smooth nepionic whorls which are more or less rounded; columella straight or twisted-truncate at base; color white, yellow, brown, orange, green, or bronzy.

LIGUUS SOLIDUS Say

Plate 1, fig. 1

1825. *Achatina solida* SAY, Journ. Acad. Sci. Philadelphia, vol. 5, p. 122.

Shell thin to solid, generally elongated, usually with rather flattened whorls; color white, cream, or yellow, sometimes variously painted; brilliantly polished and generally having a decidedly porcellanous texture; axial region white, pink, or purplish.

Western part of Cuba; Lower Florida Keys; central islands of the Upper Florida Keys.

The only character by which this species can always be separated from *fasciatus* and *crenatus* is the brilliant porcellanous texture of the shell, and certain specimens of *pseudopictus* are somewhat wanting in this, being almost glassy. Usually the color does not become darker toward the lip, but in a few *solidulus* which I have obtained on Stock Island near Key West it does. And some of these have narrow, spiral, bronzy lines on the last whorl exactly after the manner of certain forms of *crenatus*. Yet I believe that it should stand as a species distinct from *crenatus* and *fasciatus*, as I have no doubt that it represents a different line of development.

LIGUUS SOLIDUS SOLIDUS Say

Plate 1, fig. 7

1825. *Achatina solida* SAY, Journ. Acad. Nat. Sci. Philadelphia. vol. 5. p. 122.

Shell rather solid, usually elongated, very glossy and of a decidedly porcellanous texture; whorls generally somewhat flattened; sutures impressed; color ivory white to straw colored with a broad, faint yellow band above the periphery and a wide, faint yellow basal band; axial region white.

Length 44, diameter 22 mm.; length 49, diameter 24 mm.; length 63, diameter 29 mm.

Key West; Sugarloaf Key; Big Pine Key; No Name Key; Litttle Pine Key. Probably once an inhabitant of all the drier islands of the lower chain of keys. Some of the specimens received from residents of these islands are not much elongated.

LIGUUS SOLIDUS SOLIDULUS Pilsbry

Plate 1, fig. 2

1912. *Liguus solidus solidulus* PILSBRY. Journ. Acad. Nat. Sci. Philadelphia, p. 463, pl. 37, fig. 2*a*.

Shell rather thin, slightly to moderately elongated; whorls more rounded than in *solidus;* color pattern generally an ivory white ground with two narrow faint yellow bands at the periphery, one at the suture and one on the base, sometimes with a few dark, spiral lines on the last whorl; whole surface glossy and porcellanous, axial region white.

Length 60, diameter 28 mm.; length 60, diameter 30 mm.

Entire chain of the Lower Florida Keys.

I collected specimens on Stock Island which are more richly colored back of the aperture than on the rest of the shell, and some have from two to eight narrow spiral lines on the last whorl. I have in my collection a set of specimens received from an exchange and labeled "Monroe County, Fla.," one of which has no real distinction of banding but is nearly uniform yellowish on the last whorl, and another has faint, broad, yellow bands that break up into blotches.

LIGUUS SOLIDUS CRASSUS Simpson

Plate 1, fig. 8

1920. *Liguus solidus crassus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 126.

Shell very solid, of medium size, with somewhat rounded whorls; columella heavy and decidedly truncated; color a uniform ivory

white with sometimes a narrow, bronzy peripheral line; aperture having a strong, white ledge within; axial region white.

Length of type, 43, diameter 27 mm.

Big Pine Key; Ramrod Key, Frazer; Key West, Henderson collection.

In 1885 I found the type at Watson's hammock on Big Pine Key, a very solid shell with the tip slightly truncated. A shell from Key West was given me by the late Mr. John R. Henderson.

LIGUUS SOLIDUS PICTUS Reeve

Plate 1, fig. 3

1842. *Achatina picta* Reeve, Proc. Zool. Soc., London, p. 56; Conch. Syst., vol. 2, p. 178, fig. 10.

Shell thin to subsolid, polished, of medium size, with somewhat rounded whorls; columella straight or slightly twisted and rather thin; surface straw colored or grayish yellow with a pink apex and several vertical or slightly zigzag stripes on the fourth whorl which gradually pass into a double row of squarish brown spots farther down the shell and continue along the suture and periphery of the last whorl to the aperture. These spots may be opposite or alternate or irregularly placed. In addition there are occasional axial bluish smears as in *graphicus*.

Length, 41; diameter, 25 mm.

Big Pine Key; Island of Cuba, probably.

I have said elsewhere that I believe this form to be a native of Cuba and that it has only recently arrived on our shores. I see no difference in shells credited to this island and Big Pine. I have a dead shell that I collected near the present railway station on the latter and a fine specimen received from the late A. G. Wetherby labeled "*Achatina fasciata*, Cuba." In the shells I have seen the columella is white, thin, and straight, but Pilsbry states in the manual (vol. 12, ser. 2, p. 171) that it is more or less, or not, truncated. It is an exceedingly rare form of which I have seen only four specimens, and it is probably extinct in Florida.

LIGUUS SOLIDUS GRAPHICUS Pilsbry

Plate 1, fig. 10

1912. *Liguus solidus graphicus* Pilsbry, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, Vol. 15, p. 463, pl. 37, figs. 1, 1*a*.

Shell usually large, solid, more or less elongated, having flattened whorls and deep sutures; columella often slightly twisted but scarcely truncated; color, pale yellow with pink or purplish axial

region, the third and fourth whorls painted with longitudinal or slightly zigzag blotches and strigations, and these become darker and more irregular on the next two; there is a rather broad white sutural and peripheral band with a dark central line, and it is usually bordered by a dark broken line on the spire and occasionally on the body whorl. Sometimes there is a broken brown line below the white band on the body whorl. The base may be uniform yellow or flamed with irregular brown blotches, and there are generally one or two bluish axial smears on the body and penultimate whorls.

Length 69, diameter 30 mm.; length 60, diameter 30 mm.

Lower Florida Keys from Little Pine Key west to Boca Chica; West Summerland Keys of the upper chain. Formerly the most abundant of any of the forms on the Lower Keys. I have never found even recognizable fragments of it west of Boca Chica Key, but it may have formerly extended to Key West. I recently received a very well-preserved specimen which had been inhabited by a land crab from Mr. Cleveland Wells of Big Pine, who collected it on the West Summerland Keys, near the lower end of the upper chain, and I found fragments of the same on one of these islets in the thick, tropical scrub. It may have reached these islets by drifting from Big Pine Key, which is only a short distance away. Its shell is one of the most magnificent of all the land snails, being large, solid, and richly porcellaneous, highly polished and finely painted.

LIGUUS SOLIDUS LIGNUMVITAE Pilsbry

Plate 1, fig. 11

1912. *Liguus fasciatus lignumvitae* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 461, pl. 37, figs. 4 *a–d*.

Shell large, somewhat elongated, thin but strong, with slightly rounded whorls; axial region pink or purplish; general color pale or greenish yellow, sometimes almost white, often becoming ashy on the spire, the second to fourth whorls having light-brown straight or wavy axial stripes, and these become broader and purplish farther down the spire; in addition there are few to numerous bluish smears and blotches on the last one or two whorls; beginning at about the fourth whorl and extending to the aperture there is often a single or double row of dark dots at the suture, and there is a whitish peripheral band with a reddish line in its center. Besides these there are generally a few to several green spiral lines or bands on the lower half of the last whorl.

Length 65, diameter 30 mm.; length 50, diameter 29 mm.

Lignumvitae Key, mostly on the south part; Lower Matecumbe Key; abundant on both islands and less elongated on the latter.

Certain specimens from the former locality are quite solid and lack spiral green lines, approaching so closely to *graphicus* that it is difficult to separate them.

LIGUUS SOLIDUS DELICATUS Simpson

Plate 1, fig. 4

1920. *Liguus solidus delicatus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 133.

Shell usually rather thin and elongated, with somewhat flattened whorls, straw colored to buff, sometimes having an occasional narrow bluish axial smear or dark rest line; second to fourth whorls usually with faint, longitudinal, brownish lines; there is a single, narrow spiral dark line above the sutures and on the periphery, sometimes very faintly white bordered. Axial region straw colored or purplish. Rarely there are a few traces of spiral green lines on the base of the shell.

Length 65, diameter 28 mm.; length 55, diameter 25 mm.

Lower Matecumbe Key; west end of Upper Matecumbe Key; Indian Key (Wurdeman). I have several hundred specimens from Lignumvitae Key, but none that I can refer with certainty to this form. Rarely a specimen shows a few faint dots at the suture. Usually distinct from the other forms, but an occasional intermediate occurs.

LIGUUS SOLIDUS SIMPSONI Pilsbry

Plate 1, fig. 5

1920. *Liguus solidus lineatus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 121.

Shell large, usually elongated, thin but strong, with a pinkish axial region; pale greenish straw color, entirely lacking bluish smears or other variegation and without a dark peripheral band, usually with a few green spiral lines or bands on the base.

Length 60, diameter 28 mm.; length 50, diameter 26 mm.

Lignumvitae and Lower Matecumbe Keys. One shell received from Dr. H. A. Pilsbry labeled "Grassy Key." I first bestowed the name *lineatus* on this form, but Doctor Pilsbry called my attention to the fact that it had been used for a *Liguus* by Valencennes and suggested the name *simpsoni* for it. It has been very abundant on Lignumvitae Key, where it is found mostly on the northern part of the island. Certain shells of this form superficially rather closely resemble some of the specimens of *subcrenatus* but may always be distinguished on account of having a rosy apex, while that of the latter is milky white.

LIGUUS SOLIDUS PSEUDOPICTUS Simpson

Plate 1, fig. 9

1920. *Liguus solidus pseudopictus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Shell large, somewhat elongated, thin, with the axial region *white*, with slightly rounded whorls and well-impressed sutures, grayish white to greenish yellow, sometimes cream colored and having occasional bluish axial smears, the third, fourth, and sometimes the fifth and sixth whorls often having zigzag brownish lines and blotches; last whorl sometimes greenish-yellow with green, spiral lines; there is a double row of sutural squarish brown spots from columella thin and straight; texture glassy to porcellanous. There is a form with broad, brown zigzag strigations on the fourth, fifth, and sixth whorls.

Length of type 50, diameter 36 mm.; length of a large specimen 64, diameter 32 mm.

Lower Matecumbe Key near the middle of the island.

Undoubtedly derived from the form *lignumvitae* and analogous to *pictus* from which it differs in its much larger size, its thinness of shell, duller color, and white axial region. Occasional intermediates connecting it with *lignumvitae* are found. The young shells have a smoky peripheral band such as is seen in *pictus*. Some of the shells are porcellanous but the majority are but slightly so and a few have green spiral lines on the base. A form has broad, brown, zigzag stripes.

LIGUUS FASCIATUS Müller

1744. *Liguus fasciatus* MÜLLER, Verm. Terr. et Fluv., vol. 2, p. 145. 1774.

Shell imperforate, oblong-conic, smooth, usually glossy and highly painted, the colors being white, yellow, brown, green, orange, and even scarlet; whorls rounded; axial region always wholly or in part pink or purplish; columella thin and straight to thick and twisted or truncate.

Entire island of Cuba; Cozumel Island; lower Florida along the coast at Marco on the west to Fort Lauderdale on the east; Upper Florida Keys.

In a majority of the Floridian subspecies some of the earlier whorls show brownish regular or zigzag lines or even blotches, such markings being present in *castaneus*, *testudineus*, *versicolor*, *castaneozonatus*, *alternatus*, *miamiensis*, *elegans*, and occasionally in *livingstoni;* but they appear to have faded out in *roseatus*, *lineolatus*, and *ornatus*. Without a doubt this color pattern which we see strongly developed in Cuban shells of this species was one of the earlier char-

acters of *fasciatus* and in fact of the genus. It has become obliterated in all the forms of *crenatus* save *marmoratus*, in *ornatus*, in typical *solidus*, *solidulus*, *crassus*, *simpsoni*, and nearly so in *delicatus*.

The axial region in forms of *fasciatus* may be pink or purplish at the tip of the spire and white at the base or the opposite, but there is always more or less color to it, while that of *crenatus* in all its forms is pure white. This may seem like a trivial character on which to found a species, but it is the only constant one, and with Pilsbry I believe it is one of long standing, the color having faded from the forms with white axis a long time ago.

LIGUUS FASCIATUS CASTANEOZONATUS Pilsbry

Plate 1, fig. 12

1912. *Liguus fasciatus castaneozonatus* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 460, pl. 39, figs. 23, 23 *a*.

Shell rather solid, with moderately rounded whorls; axial region pink to deep purple; surface with a white ground; third whorl with faint, irregular axial or zigzag brown striations or blotches which become darker and closer until at about the fifth or sixth whorl they form a broad, more or less solid chestnut or black spiral band. There is a similar basal band and usually a narrow reddish brown peripheral line and all three extend to the aperture.

Length 43, diameter 24 mm.; length of a large shell from Key Largo 60, diameter 30 mm.

Key Vaca group; Upper Matecumbe Key northeast along the chain to Elliotts Key and on several of the small adjacent islands; Middle and East Cape Sable; Chokoloskee; the south shore of the mainland as far east as Madeira Bay; the rocky ridge of the lower east coast from Miami southwest to Long Pine Key in the Everglades; Pinecrest.

A striking and beautiful *Liguus* which is very abundant and widely distributed, occupying nearly all the region in Florida inhabited by the species to which it belongs. It is apparently wanting from Miami northward; on the west coast above Chokoloskee and on a few of the middle keys of the upper chain. At Miami it may hybridize with other forms. A *Liguus* occurs in Cuba of which I have a specimen from Salto Manantiales which is extremely close to this, and I have shells from Andros de Cisneros labeled "Isla de Cuba" very near our subspecies. It is quite possible that *castaneozonatus* or its prototype may have sprung from *blaineanus*, a Cuban form now confined within narrow limits. In some Floridian shells the dark band is more or less broken up, while in others it is nearly continuous.

LIGUUS FASCIATUS ALTERNATUS Simpson

Plate 2, fig. 1

1920. *Liguus fasciatus alternatus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Shell medium sized, rather solid, with bright pink axial region; color white with a broad, spiral, supraperipheral band consisting of alternating light and dark axial chestnut lines and bars; there is sometimes a faint, narrow peripheral reddish line and there is a broad band at the base similar to the wide one above; columella straight or very slightly twisted.

Length of type 45; diameter 24 mm.

Timb's hammock; Black Creek, Paradise Key, all in Lower Dade County, Fla.

This form, which is probably a sport from *castaneozonatus* seems to be confined to a few localities in the south end of the mainland of the State. Certain shells have the broad bands replaced in places by white or yellowish.

LIGUUS FASCIATUS ROSEATUS Pilsbry

Plate 2, fig. 7

1912. *Liguus fasciatus roseatus* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 448, pl. 38, figs. 11, 11*a*, 11*b*, 13, 15, 19, 19*a*.

Shell subsolid to solid, with somewhat rounded whorls; axial region pink to purplish; surface white, with a broad supraperipheral band of yellow, brownish yellow, or orange; rarely this band is overlaid with a few green spiral lines; there is a similar basal band and occasionally a faint narrow reddish peripheral line; parietal wall pink or tinted purplish, darker colored along its outer edge, sometimes having deep pink streaks; columella twisted and subtruncate in heavy shells, thinner and straight in less solid ones.

Length 45, diameter 25 mm.; length 40, diameter 21 mm.

Entire area occupied by *Liguus* in Florida except the extreme northeast portion, the Lower Keys, and the central part of the Upper Keys. One specimen from Pinecrest.

This is the most widely distributed form of *Liguus* in Florida, and it is not exceedingly variable. Some of the shells are very beautiful, the darker bands being a brilliant orange. Rarely a few dark spiral lines on the last whorl.

LIGUUS FASCIATUS LINEOLATUS Simpson

Plate 2, fig. 8

1920. *Liguus fasciatus lineolatus* SIMPSON, Proc Biol. Soc. Washington, vol. 33, p. 125.

Shell subsolid to solid, with somewhat rounded whorls; axial area pink or purplish red; surface whitish, flesh colored, or yellowish,

with or without a buff, greenish, or reddish spiral peripheral line; there are often one or more faint bronzy spiral lines on the base. Rarely there are one or more spiral lines on the upper part of the last whorl; columella usually twisted, almost truncate in heavy shells.

Length 63, diameter 32 mm.; length 53, diameter 27 mm.; length 37, diameter 20 mm.

Vaca group of the Upper Keys; all the Upper Keys from Upper Matecumbe to and including Elliotts Key; mainland from Marco south to Cape Sable; south shore of the mainland.

A widely distributed and variable form. Shells from the upper end of Largo and the small keys near it are often small, solid, and have more or less flattened whorls, while in others on these same islands they are large and somewhat rounded. This latter form occupies Pumpkin Key exclusively, although *roseatus* is found on Key Largo that is separated from it by only a narrow and very shallow strait. Pilsbry includes it with his *roseatus*, but it seems to me to be perfectly distinct and the two have a somewhat different distribution. Its spiral lines may occur on the periphery while those of *livingstoni* do not.

LIGUUS FASCIATUS ELEGANS Simpson

Plate 2, fig. 2

1920. *Liguus fasciatus elegans* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 124.

Shell generally small to medium size, solid, conical, with moderately rounded whorls, the second to the fifth being marked with irregular brown axial stripes and blotches; axial region a rich pink, with two or more deeper colored lines on the columellar area; general surface flesh colored; there is a reddish spiral line around the periphery and at the suture and sometimes one or more greenish ones on the last whorl; columella twisted or truncated.

Length of type 40, diameter 22 mm.; length of a large shell 58, diameter 30 mm.

A small key east of Whitewater Bay, where this and *roseatus* were the only form of *Liguus;* small hammock on Long Pine Key, one very large specimen; Paradise Key; Costello's hammock; Miami; Arch Creek; Pinecrest.

This form may be distinguished from *lineolatus* by the strigations and blotches on the earlier whorls and it inhabits an entirely different area from that subspecies, being strictly confined to the rocky ridge of the lower mainland and the Pinecrest region. I collected *Liguus* in the vicinity of Cabanas, Cuba, that very closely resemble this.

LIGUUS FASCIATUS LIVINGSTONI Simpson

Plate 2, figs. 3 and 9

1920. *Liguus fasciatus livingstoni* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 124.

Shell variable in size, solid, with rounded whorls; axial region purplish pink to deep purple, the parietal wall often showing deeper-colored streaks; surface white, usually smoky, greenish or pale yellowish green on the last whorl, with from a few to several spiral green lines on the last two whorls but wanting such markings at the periphery; columella straight or twisted.

Length of type 42, diameter 24 mm.; length of large shell 58, diameter 27 mm.

Fort Lauderdale (Squires), south along the rocky ridge to Long Pine Key in the Everglades, rare at the lower end of its area. I have a shell of *fasciatus* from Luis Lazo in Western Cuba 56 mm. in length that is very close to others that I got on cypress trees at the head of the Miami River, Fla. It agrees in size, color, markings, and weight to the last detail. The species *livingstoni* differs from *lineolatus* in having colder colors, in usually becoming darker toward the aperture and the more numerous green spiral lines which are absent on the periphery, also in lacking a reddish peripheral line; besides it has a different distribution. Recently a specimen of this has been found at Fort Lauderdale by Carl Squires.

LIGUUS FASCIATUS MIAMIENSIS Simpson

Plate 2, fig. 4

1920. *Liguus fasciatus miamiensis* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 124.

Shell usually small to medium size, subsolid, with rounded whorls; axial region light to deep purple; body of the shell whitish, the fourth, fifth, and sometimes the sixth whorls having a wide, median band consisting of irregular brown blotches often on a yellowish ground, and this usually ends abruptly on the last whorl. The latter part of the last whorl ordinarily has a number of narrow, spiral green lines which extend to the aperture.

Length 46, diameter 23 mm.; length 38, diameter 38 mm.

Ojus south and west along the rocky ridge to Paradise Key.

Doubtless a hybrid with some of the characters of *castaneozonatus*. I have a shell from Nuevitas, Cuba, which though larger and more elongated has the same general markings as this form. Some specimens of *miamiensis* have a reddish peripheral line, while others scarcely show a trace of it. It is quite likely that the ancestors of this form drifted from Cuba and became established in the great Miami hammock.

LIGUUS FASCIATUS ORNATUS Simpson

Plate 2, fig. 10

1920. *Liguus fasciatus ornatus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 124.

Shell subsolid, small to medium size, rather inflated; axial region pink or purplish; surface yellowish, always becoming darker toward the aperture, where it may be deep yellow, orange, pale yellowish brown, or even scarlet; there is sometimes a faint lighter-colored peripheral band and generally a few green or bronze spiral lines on the last two whorls; columella straight or twisted.

Length of type 46, diameter 26 mm.

Long Pine Key and hammocks along the rocky ridge to the Miami River. One specimen at Ojus.

It differs from *roseatus* in having no distinct supraperipheral band, the entire shell being yellowish or brownish, and in always being darker on the last whorl and base. Occasionally the columella is nearly white, but the apex is colored. There are intermediates between it and *roseatus*, and it may be a sport from or hybrid of that form. Some shells flush into scarlet at the aperture.

LIGUUS FASCIATUS VERSICOLOR Simpson

Plate 2, figs. 5 and 11

1920. *Liguus fasciatus versicolor* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 125.

Shell small to medium sized, solid, brilliantly polished, with somewhat rounded whorls; axial region pink or purplish at the tip but usually only slightly colored at the columellar area. The ground color may be greenish to brownish with narrow zigzag axial yellow stripes and blotches, or it may vary to yellowish, in which case the stripes and blotches are wanting, and it may have a double row of irregular brown spots at the suture and on the periphery. There is a smoky band with a lighter center at the periphery, and it may be considerably broken up or almost entire. In some shells the general tint is bluish or bluish black.

Length of type 38, diameter 22 mm.; length 40, diameter 24 mm.

Long Pine Key in the lower Everglades. This island is 8 miles long and 4 wide; it is covered with a forest of Carribbean pine and has fine hammocks scattered over it. It is in one large hammock on this key that this form has its metropolis and is rarely found elsewhere on the island. There is an abundance of material that completely connects the extremes of color in this exceedingly variable form. Very rarely there are a few faint spiral dark lines on the base of the shell. This is a wonderfully beautiful *Liguus*, the most

variable of any subspecies I know. So far as I am aware, it is confined to this large key.

LIGUUS FASCIATUS CASTANEUS Simpson

Plate 2, figs. 6 and 12

1920. *Liguus fasciatus castaneus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 126.

Shell moderately solid, rather large; apex whitish to deep pink; columella purplish white to dark purple; surface chestnut to almost black, the upper part and sometimes all of the shell marked with pale to deep yellow, irregular axial stripes which are often zigzagged; there is a broad, sometimes double smoky peripheral band with a lighter one between, and these may be almost obliterated in very dark shells; columella slightly twisted.

Length 52, diameter 28 mm.

Miami to Long Pine Key.

Typically this form is darker than *testudineus*, its near ally; it lacks the dark spiral lines of the latter and has a more distinctly defined color pattern, but there are occasional intermediates. Shells from Cox's hammock and Paradise Key are nearly black.

LIGUUS FASCIATUS TESTUDINEUS Pilsbry

Plate 3, fig. 1

1913. *Liguus fasciatus testudineus* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 457, pl. 39, figs. 20 *a* to 20 *f*.

Shell subsolid, with rather rounded whorls; axial region generally pale pinkish to purplish, the columellar area sometimes almost white; color varying from yellowish to brown; in the darker shells there is a pattern of irregular, light, wavy blotches and strigations; in the lighter-colored specimens there may be only a double series of indistinct spots at the suture; certain examples have bluish clouds on the spire; there is usually a double smoky or dark chestnut band at the periphery, with a lighter one between, and there are dark spiral lines on the last two whorls. Columella generally thin, sometimes twisted.

Length 45, diameter 23 mm.; length 43, diameter 25 mm.

Miami hammocks.

A beautiful, often glossy and very variable form which seems to be confined to the great Miami hammock. It differs from *castaneus* in being lighter colored, in its occasionally clouded surface, and in having dark spiral lines. Certain specimens closely approach some of the lighter forms of *versicolor*, but the former have the spiral lines which are lacking in the latter, though there are some intermediates. There are hybrids which have numerous spiral, green lines on the last whorl.

LIGUUS CRENATUS Swainson

1821. *Achatina crenata* SWAINSON, Zool. Ill., vol. 1, pl. 58.

Shell medium sized to large, thin to solid, usually not porcellanous, with more or less rounded whorls, typically white with spiral green lines which become slightly impressed near the aperture and end in small crenations on the thin edge of the outer lip; entire axial region always white.

Whole island of Cuba; coast of Florida from Fort Lauderdale around to Lossmans River on the west; Upper Florida Keys.

This species received the name *crenatus* because of the slight crenations at the edge of the shell where the green spiral lines end. But only the forms having these lines show crenations; and, as a matter of fact, many specimens of *fasciatus* that have similar lines show slight teeth. Usually lacking dark spiral lines at the periphery. It freely hybridizes with *fasciatus*, a fact which is proven by *Liguus* of the two types hatching from a single set of eggs here in Florida, and without doubt the same thing is true in Cuba. I have no evidence that *fasciatus* or *crenatus* hybridize with *solidus* within our borders, although on Lower Matecumbe Key *subcrenatus* is found in the same hammocks as forms of *solidus*, and on Upper Matecumbe one form of *solidus*, *delicatus*, and *matecumbiensis*, *luteus*, and *castaneozonatus* have been found and there is not the slightest intergradation. But I am inclined to believe that *solidus* and *fasciatus* hybridize in Cuba. The completely white axial region is the best distinguishing character of this species.

LIGUUS CRENATUS MARMORATUS Pilsbry

Plate 3, figs. 2, 3, 7, and 8

1912. *Liguus fasciatus marmoratus* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 455, pl. 37, figs. 9, 9*a*, 9*d*, 10.

Shell generally elongated, thin to solid, with only moderately rounded whorls, of which the first three and the entire axial region are white; on the next whorl there are irregular alternate white and brownish axial stripes, below which the ground color becomes chestnut to almost black, and it is marked with axial yellow or whitish stripes or flask-shaped blotches; there is a light band at the suture and on the periphery, and at the latter place it is usually bordered by two dark ones; last whorl generally showing dark spiral lines; aperture white within; columella thin and straight to heavy and truncate.

Length 65, diameter 28 mm.; length 43, diameter 22 mm.

Key Vaca and doubtless other islands of the Vaca group; Long Island of the Upper Keys, Key Largo; Porgy Key, doubtful; Cape

Sable; Chokoloskee; Long Pine Key; Cox's hammock; Snapper Creek; Costello's hammock; Miami hammock; Pinecrest, south-central Everglades, not typical.

A striking and very variable form, probably a hybrid, which commonly bears the name of the "black snail"; and, considering its rarity, it has a wide distribution. Rarely a shell shows bluish or greenish cloudings like *versicolor*, and one specimen from Key Vaca is marked very much like the lighter-colored forms of that subspecies. In one shell from the Miami hammock and another from Snapper Creek the axial whitish strigations continue to the base, and there is a dark peripheral band without a light center. One shell from Vaca is very thin and inflated and bears some resemblance to *Oxystyla resus*. Without a doubt this form has been an inhabitant of the Chokoloskee region. A Mr. House, who resided there, took me in his boat to a place where there was formerly a fine hammock where he said he found the black snail, but it had been cut down and made into a field. We found dead shells there which still showed that they were *marmoratus*. It is a nondescript and combines characters of *fasciatus* and *crenatus*.

I have no doubt but that this or an analogous form inhabits or has recently inhabited some part of Cuba, although, so far as I know, nothing like it has been found, and that it has migrated and become established on Key Vaca, from which it spread along the Upper Keys and crossed to the mainland on the old land bridge. It reached Chokoloskee on the southwest coast and has probably been swept across to the rocky ridge during time of a tidal wave. On this ridge it has again hybridized, this time with forms of *fasciatus*, and has produced *versicolor* on Long Pine Key; *castaneus*, which has spread up to the Miami hammock; and at the latter place it has developed into *testudineus*. Throughout this ridge occasional shells are found which have the entire axial region pure white, and these I refer to *marmoratus*.

LIGUUS CRENATUS VACAENSIS Simpson

Plate 4, fig. 10

1920. *Liguus crenatus vacaensis* Simpson, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Shell usually large, with convex spire, subsolid to solid, with deep sutures and the last and penultimate whorls slightly flattened, white or shaded greenish with sometimes a few spiral green or bronzy lines on the body or base; texture somewhat porcellanous; columella heavy and twisted or truncated.

Length of type 54, diameter 27 mm.; length of large shell 64, diameter 33 mm.

Vaca Keys; Long Island; Key Largo; Angelfish Key; Sands Key; Northwest and Middle Cape Sable (?) near Flamingo (?).

A fine, usually solid, somewhat porcellanous form which generally has the last whorls slightly flattened in the middle but well shouldered. It constantly differs from *capensis* in being less elongated and having a convex spire. I am not quite certain about the mainland specimens.

LIGUUS CRENATUS CAPENSIS Simpson

Plate 3, fig. 9

1920. *Liguus crenatus capensis* Simpson, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Shell large, solid, much elongated, with straight sides and somewhat chalky texture; whorls slopingly flattened; sutures not very deep; surface white or slightly greenish tinted on the last whorl, with a few to several spiral lines on the last or last two whorls, those above the periphery green and the basal ones ashy brown; aperture small, rather short, the outer lip not greatly oblique; columella generally thin and straight or only slightly twisted.

Length of type 58, diameter 27 mm.; length 60, diameter 26 mm.

Northwest, Middle, and East Cape Sable; hammock near Flamingo; near Cuthbert Lake 20 miles east of Northwest Cape Sable (Livingston).

More elongated than any other Florida *Liguus*, with very straight sides and ashy brown basal lines. A specimen found on Northwest Cape Sable in 1885 had a broad, brilliant green belt above the periphery, but it fell into the grass and was lost. The green lines are often worn away on living shells.

LIGUUS CRENATUS MATECUMBENSIS Pilsbry

Plate 3, fig. 4

1912. *Liguus crenatus matecumbensis* Pilsbry, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 446, pl. 37, figs. 5, 5*a*.

Shell medium to large, rather thin to subsolid, varying from somewhat slender to inflated, with but slightly rounded whorls and a faint angulation just below the periphery, creamy white to pale greenish yellow with a few spiral green or bronzy lines on the last whorl or two, spire rounded; aperture large, rather long; outer lip oblique; columellar area creamy to yellowish; there is sometimes a golden flush on the parietal wall; columella thin and incurved.

Length 55, diameter 29 mm.

Length of a slender shell 50, diameter 23 mm.

Upper Matecumbe Key; Middle and East Cape Sable; Flamingo and hammocks in the vicinity; east to Madeira Bay. Very abundant on the mainland.

This differs from other forms of *crenatus* in the large aperture, the incurved columella, and the more oblique outer lip. In most shells the colored lines become abraded during life and sometimes change from green to bronze. In some shells the yellow columellar flush is present; in others it is wanting.

LIGUUS CRENATUS SUBCRENATUS Pilsbry

Plate 3, fig. 10

1912. *Liguus crenatus subcrenatus* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 445, pl. 37, figs. 7, 7*a*.

Shell large, rather elongated, thin but strong, with but slightly rounded whorls; surface glassy white except the apical region which is dull or milky white; last whorl having a few spiral green lines which are mostly on the base; columella thin and straight.

Length 60, diameter 28 mm.; length 70, diameter 32 mm.

Grassy, Lower Matecumbe, and Windleys Keys; Long Island; Key Largo.

A thinner shell than *vacaensis*, and it has less convex sides; it is more glassy, being almost as much so as *septentrionalis*. Sometimes the later whorls are slightly tinted with green. The shell whose dimensions are last given and which I collected on Windleys Key is the largest *Liguus* I have seen from Florida. Apparently about a quarter of an inch of its apex has been broken off and sealed up, and if it were perfect it would probably measure 77 mm. It very likely had nine whorls, though most shells of this form have but eight. I collected *Liguus* at Cape San Antonio, Cuba, which were quite similar to this subspecies.

LIGUUS CRENATUS ELLIOTTENSIS Pilsbry

Plate 3, fig. 11

1912. *Liguus crenatus elliottensis* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 447, pl. 37, figs. 3, 3*a*, 3*b*.

Shell small to medium sized, somewhat inflated, thin and usually fragile, with six to six and a half whorls which are generally but slightly rounded, lusterless white, sometimes having transparent gray streaks, and occasionally dark spiral lines on the lower half of the last whorl; columella thin and straight or but slightly twisted.

Length 37, diameter 20 mm.; length of a large dead shell from Old Rhodes Key 44, diameter 25 mm.

Elliotts Key; Old Rhodes Key; Scott's place on Key Largo (National Museum collection).

A small form with rather negative characters, being thin and simply colored. I found a number of dead specimens on Old Rhodes

Key, some of them being considerably larger than those from Elliotts Key. Pilsbry, who has seen numerous perfect shells, says that there is a faint yellow sutural line and usually some yellowish olive green, chiefly basal lines.

LIGUUS CRENATUS LUTEUS Simpson

Plate 3, fig. 12

1920. *Liguus crenatus luteus* Simpson, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Shell varying from small to large and from thin to solid; axial region white, with the columella generally twisted or subtruncate; whorls somewhat rounded, with the sutures well impressed; color varying from straw or pale yellow to deep yellow or orange, lighter to white on the earlier whorls, sometimes having from one to several narrow dark or green spiral lines on the last whorl at or above the periphery and fainter lines on the base.

Length of type 63, diameter 18 mm.; length 38, diameter 18 mm.

Vaca group of the Upper Keys; east end of Upper Matecumbe, one specimen; Kep Largo (C. E. Saxton), a fine young specimen; rocky ridge on the south and southeast mainland from Long Pine Key east and north to Dania; Pinecrest, very brilliant.

In most shells there is a sort of ledge inside at the aperture composed of the dull white matter of the interior, and the outer lip is thin and darker colored. Some of the specimens from Key Vaca have the last whorl brilliantly tinted with orange, and I have shells collected back of Larkins and about Dania, the latter locality being near the northern limit of *Liguus* on the east coast, which are very close to the Vaca material. It is an abundant form, and as I have remarked, it is the first to inhabit the incipient hammocks of the great rocky ridge. In some of the larger hammocks it is the only occupant.

LIGUUS CRENATUS CINGULATUS Simpson

Plate 3, fig. 6

1920. *Liguus crenatus cingulatus* Simpson, Proc. Biol. Soc. Washington, vol. 33, p. 123.

Shell medium to large sized, thin to subsolid, somewhat shining; whorls varying from flattened to somewhat rounded, pure white, with a broad, pale yellow spiral band above the periphery and another below it; columella twisted.

Length of type 33, diameter 20 mm.

Long Island of the Upper Keys; Key Largo; Middle Cape Sable; East Cape Sable; Flamingo; Long Pine Key (?); Timb's hammock; Lysiloma hammock, both in Lower Dade County; Miami; Lemon City.

Although this form is widely distributed it seems to be rather rare. Exeternally it is colored much like certain specimens of *Liguus fasciatus roseatus*, but the axial region is pure white throughout. The yellow is paler than it is in that form.

LIGUUS CRENATUS EBURNEUS Simpson

Plate 4, fig. 1

1920. *Liguus crenatus eburneus* SIMPSON, Proc. Biol. Soc. Washington, vol. 33, p. 122.

Shell rather solid, usually of a somewhat porcellanous texture, obese to rather elongated, with rounded whorls, pure or ivory white throughout or rarely having traces of spiral bronzy lines on the base or at the aperture; columella twisted.

Length of type 52, diameter 26 mm.

Timb's hammock, type locality; hammocks along the rocky mainland ridge from Long Pine Key to Lemon City and opposite it on the peninsula; Pinechest, not typical. Has a somewhat porcellanous texture and usually is without traces of spiral lines.

LIGUUS CRENATUS MOSIERI Simpson

Pate 4, fig. 2

1920. *Liguus crenatus mosieri* SIMPSON, Proc. Biol. Soc. Washington. vol. 33, p. 123.

Shell variable in size, subsolid, somewhat polished; whorls moderately to well rounded, the earlier ones white or whitish, the last ones darker, often smoky tinted or dirty greenish and having from two to several green or bronzy spiral lines which are wanting at the periphery; columella straight or slightly twisted.

Length of type 45, diameter 24 mm.; length of a large shell from Miami 50, diameter 27 mm.

Hammocks from Arch Creek southward and westward along the great rocky mainland ridge to Long Pine Key, being most abundant at Miami, the type locality.

This subspecies is nearer the typical Cuban *crenatus* than anything we have, but it averages much smaller than that. However, I have seen shells from Cape San Antonia and other localities in that island that are no larger than the ordinary *mosieri*.

LIGUUS CRENATUS SEPTENTRIONALIS, Pilsbry

Plate 4, fig. 3

1912. *Liguus crenatus septentrionalis* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2 vol. 15, p 447, pl. 37, figs. 6, 6*a*.

Shell thin but strong, inflated, with but slightly rounded whorls, the last usually subangulate at the periphery, with glassy surface,

pure white or slightly greenish, with from one to seven spiral narrow green or bronzy lines on the last whorl that may extend to the penultimate one; aperture large; outer lip thin; columella straight.

Length 48, diameter 27 mm.; length 42, diameter 23 mm.

Great hammock near Fort Lauderdale; hammocks along the outer shore opposite the town and to the northeastward; south side of New River near its mouth; hammock about a mile south of Fort Lauderdale; hammock north of Arch Creek, where both typical specimens and those hybridized with *fasciatus* were found. A form nearly typical was taken just south of Little River stream.

A well-characterized subspecies, being thin, short, and inflated, highly polished and glassy, usually with a decided peripherial angulation. Sometimes the spiral lines are brilliant green, or they may be bronzy; they are rarely wholly wanting. It has been found in the shore hammock more than 2 miles north of Fort Lauderdale, and this is the most northern authentic locality for *Liguus* in the State of Florida; I have a specimen of *Liguus* from the village of Jamaica, Cuba, which is very close to *septentrionalis*, the only difference being that the Cuban shell is a little more solid and has a slight ledge within the aperture.

LIGUUS CRENATUS LOSSMANICUS Pilsbry

Plate 4, figs. 4 and 9

1912. *Liguus crenatus lossmanicus* PILSBRY, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 448, pl. 37, figs. 8 *a*, *b*.

Shell usually small to medium size, inflated, and having decidedly rounded whorls, subsolid to solid; axial region pure white, the columella ordinarily strongly twisted and truncate; there is in the more solid shells a decided ledge or shoulder just inside the aperture; color white, greenish, or yellowish white, usually dull; often there are a few green or bronzy spiral lines and sometimes a dull, broad, yellowish band above and below the periphery.

Length of a shell from the type lot 40, diameter 23 mm.; length of a large shell from Middle Cape Sable 55, diameter 30 mm.

Lossmans Key on the southwest coast to Middle Cape Sable; Rodgers River; John Douthett's place near Flamingo.

A peculiar form and somewhat variable for one having such a limited distribution. Most of the shells are short, solid, with rounded whorls; but others which I refer to this are somewhat lighter in build, are more lengthened, and have less decidedly rounded whorls, and these usually do not show the strong inside ledge. But the two seem to intergrade. Dr. Edward Mercer and I found an extensive colony in an isolated hammock at Middle Cape Sable where some specimens were quite large and had the last whorl flattened

at the periphery and another had a broad faint yellow supraperipheral and a basal band. With these were a number of what were evidently hybrids between *lossmanicus* and *castaneozonatus*, having a variety of dark bandings, while others were entirely white, with a purple axial region.

EXPLANATION OF PLATES

PLATE 1

FIG. 1. *Liguus solidus* Say, Hammock west of station, Big Pine Kay.
2. *Liguus solidus* Pilsbry, Stock Island.
3. *Liguus solidus pictus* Reeve, Cuba.
4. *Liguus solidus delicatus* Simpson, Lower Matecumbe Key.
5. *Liguus solidus simpsoni* Pilsbry, figured type, Lignumvitae Key.
6. *Liguus fasciatus* var. Like *castaneozonatus*, Salto de Marianales, Cuba.
7. *Liguus solidus* Say, Big Pine Key, inflated.
8. *Liguus solidus crassus* Simpson, Watson's hammock, Big Pine Key.
9. *Liguus solidus pseudopictus* Simpson, Lower Matecumbe Key.
10. *Liguus solidus graphicus* Pilsbry, Torch Key.
11. *Liguus solidus lignumvitae* Pilsbry. Lower Matecumbe Key.
12. *Liguus fasciatus castaneozonatus* Pilsbry, Long Pine Key.

PLATE 2

FIG. 1 *Liguus fasciatus alternatus* Simpson, Timb's hammock, Dade County.
2. *Liguus fasciatus elegans* Simpson, hammock in lower Everglades.
3. *Liguus fasciatus livingstoni* Simpson, type, Miami.
4. *Liguus fasciatus miamiensis* Simpson, type, Miami.
5. *Liguus fasciatus versicolor* Simpson, type, Long Pine Key.
6. *Liguus fasciatus castaneus* Simpson, Long Pine Key.
7. *Liguus fasciatus roseatus* Pilsbry, Key Largo.
8. *Liguus fasciatus lineolatus* Simpson, type, Goodland Point, Collier County.
9. *Liguus fasciatus livingstoni* Simpson, large, head of Miami River.
10. *Liguus fasciatus ornatus* Simpson, type, Paradise Key.
11. *Liguus fasciatus versicolor* Simpson, variety, Long Pine Key.
12. *Liguus fasciatus castaneus* Simpson, black variety, Long Pine Key.

PLATE 3

FIG. 1. *Liguus fasciatus testudineus* Pilsbry, Miami.
2. *Liguus crenatus marmoratus* Pilsbry, variety, Key Vaca.
3. *Liguus crenatus marmoratus* Pilsbry, Chokoluskee.
4. *Liguus crenatus matecumbiensis* Pilsbry, near Flamingo.
5. *Liguus crenatus*, like small *subcrenatus*, Cape San Antonio, Cuba.
6. *Liguus crenatus cingulatus* Simpson, type, Miami.
7. *Liguus crenatus marmoratus* Pilsbry, Key Vaca..
8. *Liguus crenatus marmoratus* Pilsbry, Miami.
9. *Liguus crenatus capensis* Simpson, type, northwest Cape Sable.
10. *Liguus crenatus subcrenatus* Pilsbry, Lower Matecumbe Key.
11. *Liguus crenatus elliottensis* Pilsbry, Elliotts Key, type lot.
12. *Liguus crenatus luteus* Simpson, type, Key Vaca, near Conch town.

PLATE 4

FIG. 1. *Liguus crenatus eburneus* Simpson, Paradise Key.
2. *Liguus crenatus mosieri* Simpson, type, Miami.
3. *Liguus septentrionalis* Pilsbry, Fort Lauderdale.
4. *Liguus crenatus lossmanicus* Pilsbry, Lossmans Key, type lot.
5. *Liguus* hybrid of *lossmanicus and fasciatus*, Middle Cape Sable.
6. *Liguus crenatus* from Trinidad Mountains, Cuba, close to *eburneus*.
7. *Liguus crenatus* from Santa Cruz del Morte, Cuba, close to *mosieri*.
8. *Liguus crenatus* from Jamaica, Cuba, very close to *septentrionalis*.
9. *Liguus crenatus lossmanicus* Pilsbry, large, from Middle Cape Sable.
10. *Liguus crenatus vacaensis* Simpson, Key Vaca.

O

E. B. Decker.

FLORIDA TREE SNAILS OF THE GENUS LIGUUS.

For description of plate see page 43.

FLORIDA TREE SNAILS OF THE GENUS LIGUUS.

For description of plate see page 43

FLORIDA TREE SNAILS OF THE GENUS

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FLORIDA TREE SNAILS OF THE GENUS LIGUUS.

For description of plate see page 44.

CONCERNING THE ORIGIN OF THE METAL IN METEORITES

By George P. Merrill

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The peculiar relationship existing between the metallic and silicate portions of a stony meteorite has been noted by several, and particularly the earlier workers. The present writer has on more than one occasion (noted later) made reference to it and also to the work of others. In discussing the matter among his contemporaries he finds, however, a considerable difference of opinion such as has led to the preparation of this paper in which he reviews these opinions and gives the results of his own observations.

In his discussion of the composition of the Lodran meteoric stone, Tschermak wrote [1] as long ago as 1870:

> Das Nicheleisen und der Magnetkies müssen später fest geworden sein als die übrigen Mineralien, und ihre Bildung dürfte zu gleicher Zeit mit jenen Veränderungen vor sich gegangen sein, welche der Olivin erlitten zu haben scheint.

With reference to the metallic constituent of the Homestead meteorite, Gumbel wrote, five years later:

> Noch häufinger erscheinen die aus Meteoreisen bestehenden körnchen der Gesteinmasse in meist zackigen, winkelig gebogenen, oft in feine Spitzen auslaufenden Klumpchen beigemengt, welche so innig an die nicht metalischen Theile sich ausschmiegen als ob das Eisen erst zuletzt etwa durch Reduction an der Stelle ausgeschieden worden wäre, wo es sich vorfindet.[2]

So far as I am aware these are the first suggestions of their kind, though they seem to have attracted little attention from other workers.

Before entering upon the discussion of these and other views yet to be noted, the following illustrations of actual conditions are given.

Figure 1, Plate 1, is from a photomicrograph of the chondritic stone from Anthony, Kans., recently described.[3] The dark center (1) is troilite; the lighter border (2) metal, which forms, as it were, a

[1] Sitzbericht d. k. Akad. der Wiss. II Abtheil., 1870.
[2] Sitzbericht München Akad. der Wiss., vol. 5, 1875, p. 325.
[3] Proc. Nat. Acad. of Sciences, vol. 10, p. 306.

binding or cementing constituent holding the fragments together. The manner in which the metal projects into the interstices of the silicates is to be noted. Instances of this nature are common in many chondritic meteorites, both crystalline and otherwise.

Figure 2 of the same plate is that of a fragment of a dark chondritic stone embedded with others of a quite different nature, as described in my paper entitled "The Cumberland Falls, Kentucky, Meteorite," published in 1920.[4]

Attention was there particularly called to the fine threadlike forms sometimes assumed by the metal, (1) white in the figure. These veinlets or stringers vary from 1 or 2 millimeters in thickness to mere films of only microscopic dimensions, and divide and subdivide repeatedly, their ramifications reaching out and completely surrounding or penetrating into the silicates along cleavage or fracture lines.

A noticeable layer of metal, too, lies along the boundary line of the fragment, a condition which it was thought might indicate a deposition of the material since the consolidation of the stone in its present brecciated form.

Figure 3 is that of a slice of a pallasite belonging to the Rökicky group, found at Admire, Kans., and described in 1902.[5]

The dark areas are olivine, the white (1), nickel-iron with scattered particles of schreibersite (2), and troilite (3). The feature of importance in the present instance, is the angular character of the olivines. It is to be noted that they are not products of crystallization, in situ. They are rather fragments, in some cases mere splinters, as sharply angular as so much shattered glass. These are firmly embedded in the metal with no signs of corrosion or alteration indicative of heat or moisture. The same is true of the Eagle station meteorite and others of its class.

Figure 4 is from the Four Corners meteorite. This consists largely of a coarsely granular aggregate of metal inclosing fragments of disintegration from a fine granular pyroxenic rock, now in some cases reduced to mere sand. The metal, as shown at (1) completely incloses these silicate particles (2) and in places penetrates slightly into their interiors. The stony fragments are all unchanged, with no sign of corrosion by heat or otherwise, even when in the condition of finest sand, no slag nor glass; the contact is as sharp and free from signs of alteration as though the admixture had taken place when cold.

The above illustrations are sufficient, it is thought, to show that, so far as chondritic meteorites and those of the Rökicky and Four Corners type are concerned, the metal is the last constituent to congeal, and that it is probably wholly of secondary origin. The ques-

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[4] Proc. U. S. Nat. Mus., vol. 57, 1920, pp. 97–105.

[5] Idem, vol. 24, 1902, pp. 907–913.

tions for consideration are, then, (1) what is the source of the material and its manner of deposition and (2) will the same explanation apply to the pallasites, particularly those of the Rökicky group which seems applicable to the stony forms.

Nordenskiold in his description in 1879 [6] of the Stalldalen meteorite expressed himself in agreement with the writers above quoted in the view that the metal is the latest formed of the constituents and suggested the possibility of its preterrestrial origin through the reduction of some ferruginous silicate. To quote his own words:

I afseende a den nu ifrågavarande gruppen är det af dessa meteoriters mikroskopiska struktur tydligt, att det metalliska jernet utgör dessa meteorstenars yngsta beståndsdel och att det saledes uppkommit genom reduktion af de jernhaltiga silikaterna.

This would seem to be essentially in agreement with Daubree [7] who as a result of experimental work inclined to the view that the metal was due to the reduction of a highly ferriferous olivine in an atmosphere of hydrogen, with the simultaneous production of an iron magnesium silicate (enstatite). An exception was taken to this view by Fletcher,[8] who pointed out the existence of pallasites like that of Krasnojarsk, rich in both iron and olivine but quite lacking in enstatite.

Meunier in his article on Meteorites [9] has discussed the matter in considerable detail. He wrote:

Les manipulations auxquelles les fers météoriques out été sourmis par divers experimentateurs n'ont par tardé à montrer que ces roches cosmiques sont profondement desorgansees par le fait d'une fusion pure et simple, * * *. Il etait donc necessaire de rechercher une méthode propre a fournir, autrement que par fusion, des alliages de fer et de nickel semblables a ceux des météorites.

And further:

Le protochlorine de fer étant decomposé au rouge par l'hydrogene, on peut admettre que ce qu'on en trouve a simplement échappé à le décomposition et represénte la combination même d'on la fer a été tiré pour prendre l'état métallique.

The suggestion of Jetrofeioff and Latschinoff [10] in 1888 to the effect that the meteorite consists of an isomorphous mixture of the

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[6] Geol. Froeningen Stockholm Forhandlinger, 1878–79, p. 60.

[7] Geol. Experimentale, 1879, pp. 517, 520.

[8] Introduction to the Study of Meteorites, 1908, p. 33.

[9] Encyclopedie Chimique, 1884, p. 322.

[10] Es ergeibt sich auch, dass der Meteorit einem isomorphen Gemenge der Silicate $Mg_2 SiO_4$ und $Fe_2 SiO_4$ naher steht, als selbst der Olivin von Fogo. Man gelangt hiernach unwillkührlich zur Voraussetzung, dass der Meteorit ursprünglich ein Olivinmagma darstellte, welches später unter Einwirkung reducirender Körper, wie Wasserstoff der Kohlenoxyd oder Kohlenwasserstoffen unter Abschiedung von metallischen Eisen aus dem Magma und gleichzeitiger Abscheidung von Kohlenstoff aus der reducirenden Verbindung, sich differenzirte. Die freigewordene Kieselsäure ging auf Bildung von Augit. Diese differenz wird zugleich mit der Erhärtung der Hauptmasse des Olivin stattgefunden haben und haben sich daher kohlige Substanz und Nickeleisen hauptsächlich an den Umrandungen der Körner abgesetzt. Es dürfte so auch ras Vorhandensein der Eingangs erwähnten ebenen Aussenflächen des Steines erklärlich werden. (Der Meteorit von Nowo-Urei, M. Jerofeieff und P. Latschinoff in St. Petersburg, 1888.)

silicates Mg_2SiO_4 and Fe_2SiO_4 which under the reducing action of hydrogen, carbon[11] monoxide, or hydrocarbons have been reduced and differentiated with the separation of the metal and silicate minerals, however applicable in cases of direct crystallization from a molten magma, are scarcely so in the cases of the clastic rocks here under discussion and may be passed over. Moreover the suggestion of Fletcher already quoted, still holds good.

Ideas expressed by Dr. W. Wahl with reference to brecciated structures such as are shown by the Deesa and some other irons are of interest. He says:

> Wie aus der vorhergehenden Beschreibung ersichtlich ist, hat der Silikatanteil unbehindert von dem Metallteile des Gesteins krystallisiert; er hat sich wie innerhalb der Hohlräume eines Schwammes, dessen Gerüst der metallische Anteil war, verfestigt. Aber zur Zeit der Verfestigung der zwischenliegenden Silikatmasse muss das Metallgerüst noch selbst flüssig gewesen sein, denn die Silikate sind dem Metall gegenüber scharf idiomorph ausgebildet und hierdurch erhielten die Eisenteile ihre zackige Begrenzung. Es hat folglich das Magma, aus dem der Siderolith hervorging, vor dem Erstarren aus einem inhomogenen Gemische zweir Flüssigkeiten bestanden, die sich noch nicht entmischt hatten und von denen die eine aus den Plagioklas- und Pyroxensilikaten, die andere aus flüssigem Metall und Metallverbindungen (gediegen Eisen mit Cohenit und etwas Schreibersit? Magnetkies und etwas Magnetit?) zusammengesetzt waren. Die verschiedenen Proportionen zwischen dem metallischen Anteil und silikatanteil erklären sich dann durch eine teilweise Entmischung und durch ein Zerbrechen von schon auskrystallisierten Silikat-partien sowie Hineingeraten derselben in den noch flüssigen metallischen Anteil. In dieser Weise entstand möglicherweise das von Daubrée beschriebene Stück. [i. e., the Deesa Iron.]

The inference here is that the metal is in a condition of fluidity such as could be imparted only by heat. If so the matter is certainly open for further discussion. That it is possible the meteorites of the pallasite group may result from the direct cooling of two immiscible liquids, the metal, owing to its higher fusibility, cooling first and inclosing the gradually solidifying silicate drops, need not here be argued. That, however, the brecciated structure shown in Figures 3 and 4, or the deposits of metal in the interstices of the silicates as in 1 and 2 could thus originate is doubtful.

There is in this connection a view relative to these metal-silicate breccias, belonging to the Rökicky group, that may be worthy of consideration, and in which the question of the origin of the metal itself is not necessarily involved. Is it not possible that this brecciation may be due to pressure acting upon the mass of a normal pallasite after solidification rather than when the metal is in a fluid condition, as Doctor Wahl's paper implies? The metal, being the more plastic, would flow, while the silicates would be crushed. In this

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[11] The possible instrumentality of carbon as a reducing agent was also considered by Nordenskiold in the paper already noted and the idea dismissed as improbable.

way the slight amount of displacement sometimes shown by the silicate particles (fig. 3, plate 1, and upper plate 2) could be accounted for. It may be questionable, however, if under such conditions the original tripartite character of the metallic alloys would not be destroyed or disarranged. In the case of the Admire meteorite the metal gives no visible indications of any such movement.

It would seem scarcely necessary to consider the possibility of the iron as having been introduced or injected in the ordinary condition of molten fluidity. The melting point of pure iron is, as given, 1,530° C.; that of nickel 1,452° C. The pyroxenes, on the other hand, fuse at approximately 1,400° C., and olivines at 1310°–1430° C. (according to Doelter). Apparently it could not then be a question of simple dry fusion as the silicates would be reduced to the condition of slag—"profondement désorganées," as Meunier expressed it. Existing conditions can be explained, moreover, without assuming that the metal has at any time been in a condition of fusion. Direct reduction of an ore as practiced in the early days of iron smelting, or as still practiced in the well-known Catalan process, results in the production at temperatures not above 700° or 800° C. of a spongy or pasty mass of metal. It is easy to conceive that such material, commingled with rock fragments and subjected for sufficient time to a moderate pressure, might give rise to the structures described, particularly such as shown by the Four Corners iron.[12]

Another feature which may have a bearing upon the subject is this. Meteoric irons almost invariably partake of the nature of the so-called "wrought iron," in that they are soft and malleable. Reports to the contrary can be accounted for only on the supposition that the material selected was a mixture. Some irons, like that of New Baltimore, Pennsylvania, can be hammered down when cold; others are more brittle but still malleable.[13] Fused in an ordinary gas furnace in the laboratory these soft irons yield a bead no longer malleable but hard and brittle like ordinary cast iron and with an entirely different microscopic structure.[14] (See pl. 3.)

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[12] I am indebted to Prof. Albert Sauveur, of the Harvard Engineering School, to whom I sent a photograph of the slice shown in fig. 4, pl. 1, for the following suggestion:

"The structure to which you call my attention recalls somewhat that of wrought iron, in which we also find particles of silicates embedded in an iron matrix. This results from the fact, as you undoubtedly know, that in the manufacture of wrought iron the reduced metal is not melted, but remains pasty, retaining some of the liquid silicates or slag very much as a sponge retains water. Also, just as further cooling of the sponge results in particles of ice within the sponge, so further cooling of the wrought iron results in particles of silicates within the iron matrix. I wonder whether such a process might have been at work in this case? It would, of course, imply reduction of an iron oxide or of an iron salt at such low temperature that the reduced iron remains below its melting point."

[13] The United States National Museum collections contain two knife blades 7 and 14 inches long hammered out of the Coahuila and Nejed irons, respectively, by our local blacksmith in a small charcoal forge. Though easily shaped they could not be tempered.

[14] These experiments have not been carried far enough nor with sufficient refinement to allow the drawing of safe conclusions other than those mentioned.

All the evidence at present available, as I interpret it, points to the origin of the metal as introduced at a temperature lower than that of the melting point of the silicates. As above noted, a reduction of a ferriferous silicate either through the aid of carbon or hydrogen is ruled out of consideration by the complete absence of any secondary or residual products. Of all other known meteoric constituents the ferrous chloride, lawrencite, would seem to best meet the apparent necessities of the case. It is found in varying though small proportions an almost universal constituent, and it is permissible to imagine its one-time presence in vastly greater quantities. It is reduced according to Meunier and, as already noted, at a temperature not exceeding 400° C. (750° F.) in an atmosphere of hydrogen. It would seem, then, not too much to assume that this mineral was, as Meunier conceived, the original source, and the fractional amount of chlorine found in nearly all meteorites, stony as well as metallic, but an unreduced residue. And further, it is possible to conceive of a hot mass of commingled rock fragments and ferrous chloride, in which the latter is being reduced to the condition of a metallic paste in which the fragments become engulfed as in Figures 3 and 4, Plate 1, or simply cemented as in Figure 1. It must not be forgotten that H. C. Sorby as long ago as 1864 suggested that the metallic constituents of meteorites were introduced into the interstices of the silicates in a state of vapor.

Such a conception would seem to be particularly applicable to the metal in a stone like that of Estherville, Iowa, in which the iron is in slag or spongelike masses not always closely compacted in all its parts with the silicates.[15] (Fig. 2, lower.) Tschermak's observation on this is of interest. He wrote:[16]

> Das Eisen verhält sich oft so, als ob es die letze Bildung wäre eine impregnation welche die zum Theil krystallinische, zum Theil Tuffartige masse durchdrungen hat.

Meteorites are unmistakably volcanic products.

It is fair then to consider the original chloride itself a product of volcanic emanations as in terrestrial volcanoes. There would, in result, be this difference, however: The chloride of terrestrial volcanoes exposed to an oxygen-rich atmosphere manifests itself almost at once as an oxide. In a heated atmosphere of hydrogen or other reducing gases such as it is possible to imagine exists at the fountain source of meteorites a contrary result would be effected and the iron appear in metallic form.

This source would then be comparable to that of the metal in the basalt of Bühl bei Cassel, Germany, as described by Eitel in his re-

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[15] See Notes on the Meteorite of Estherville, etc., Proc. U. S. Nat. Museum, vol. 58, 1920, pp. 22–24.

[16] Sitz. Kais. Akad. Wien, vol. 88, 1883, p. 253.

view of the Researches of F. Flade.[17] The metal in this case, it will be remembered, is shown to have been reduced from magnetic pyrites. That, however, in the meteorite it was not derived from the sulphide is shown apparently by the fact that the latter is the later formed mineral of the two.

Objection to such a possible source might be raised on account of the large amount of chloride demanded to produce the 10 per cent and upward of metal contained by the average stone. (Lawrencite, $FeCl_2$=Fe 40.1 per cent, Cl 55.9 per cent.) Could it be allowed, however, it would be an aid in accounting for the enormous quantities of sodium chloride in seawater and locked up in the rocks of the earth's crust.

EXPLANATION OF PLATES

Plate 1

Fig. 1. Anthony (Kans.) stone. (1) Troilite; (2) nickel-iron. Dark, nearly black areas, silicates.

2. Dark inclosure in Cumberland Falls stone. Small white dots and stringers (1) are metal. Dark areas, silicates.

3. Admire (Kans.), pallasite. (1) Nickel-iron, (2) schreibersite, (3) troilite. Dark areas, olivine.

4. Four Corners (N. Mex.), iron. (1) Nickel-iron, (2) granular admixture of silicates and metal.

Plate 2

Upper. Polished slice of Admire pallasite, showing clastic structure and shattered condition of olivines. Natural size.

Lower. Polished slice of Estherville mesosiderite, showing shrinkage cavities black, metal white, silicates dark gray. Enlarged about four diameters. 1 Silicate; 2 metal; 3 cavities.

Plate 3

Upper. Structure of Mount Joy meteroric iron—a coarse kamacite octahedrite—after fusion.

Lower. Structure of Canon Diablo iron—a coarse octahedrite—after fusion.

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[17] Das Bühleisen hat alle Eigenschaften eines extrem niedrig gekohlten Schmiedeeisen, is infolge dessen ausserordentlich zähe und dehnbar, aber nur schwer mit der Gesteinschneidemaschine oder mit der Säge zuzerkleinern. (Senkenbergia, vol. 2, Heft 5, Aug. 15, 1920.)

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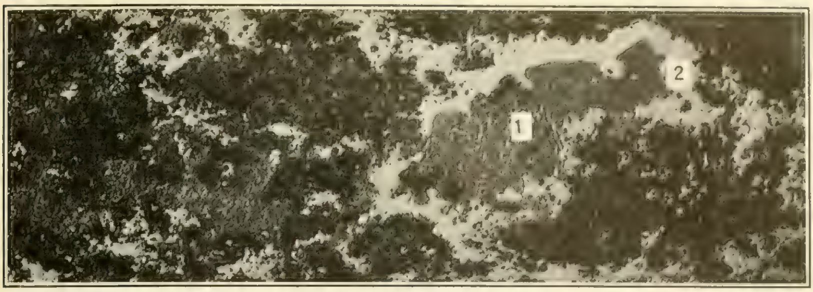

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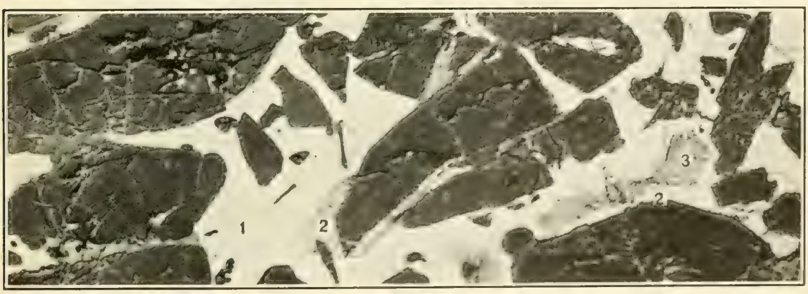

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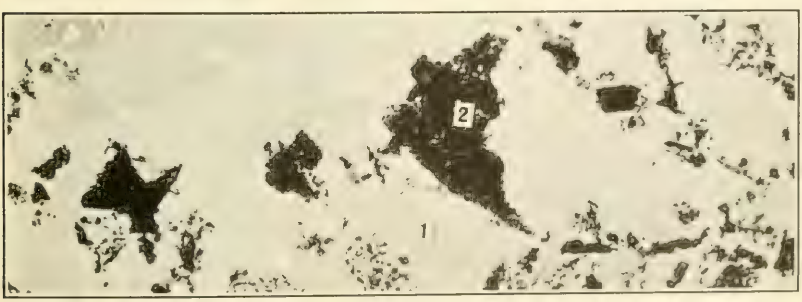

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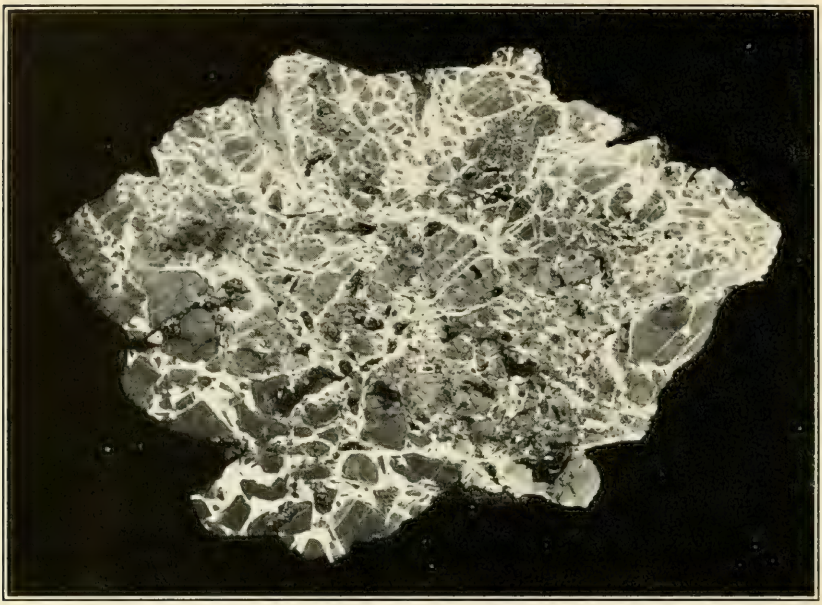
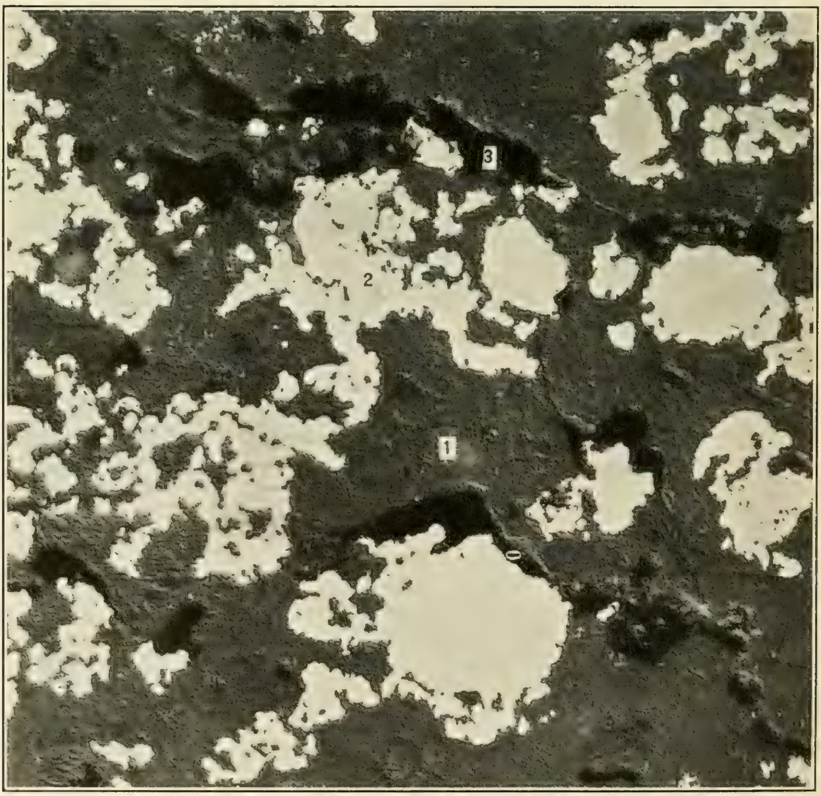
ORIGIN OF METAL IN METEORITES

FOR EXPLANATION OF PLATE SEE PAGE 7





ORIGIN OF METAL IN METEORITES

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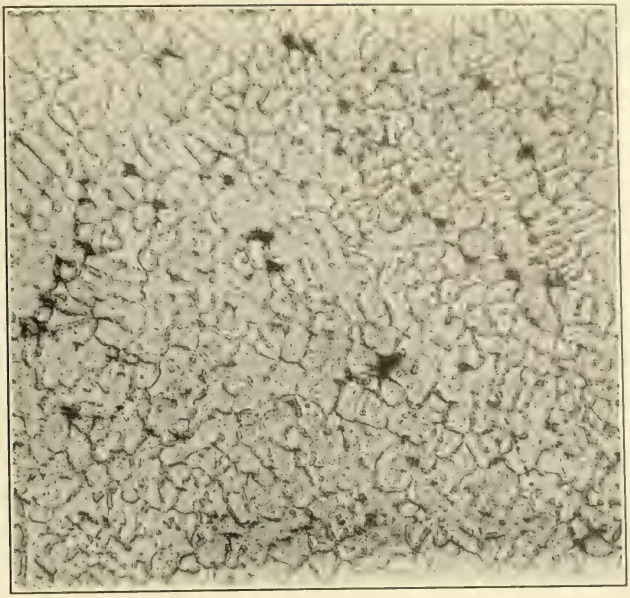

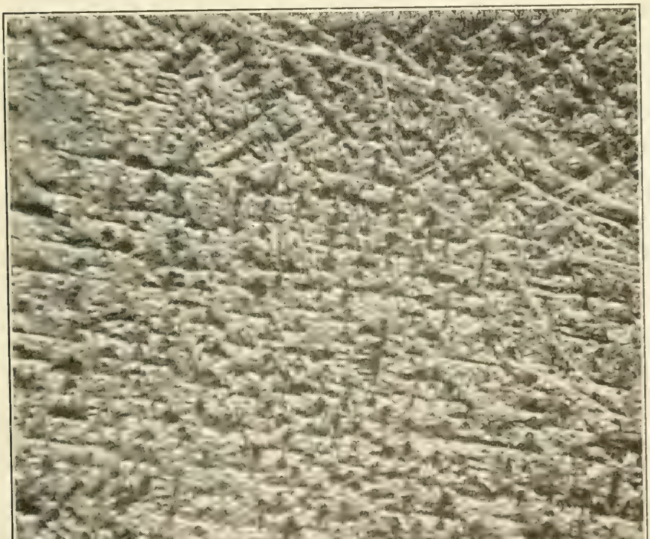

ORIGIN OF METAL IN METEORITES

FOR EXPLANATION OF PLATE SEE PAGE 7

TERTIARY FOSSIL PLANTS FROM THE ARGENTINE REPUBLIC

By Edward W. Berry

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INTRODUCTION

There are in the United States National Museum several small lots of rather indifferently preserved fossil plants collected by Chester W. Washburne in the Territories of Rio Negro and Santa Cruz during the explorations of the Hydrological Survey made for the Government of Argentina under the direction of Bailey Willis in 1911–1913. All are impressions of foliage, for the most part fragmentary, and preserved in clayey or sandy tuffs. The character of the material and its small amount render it impossible to deduce any far-reaching conclusions; nevertheless, considerable that is of interest has resulted from its study.

In striking contrast with the wealth of information regarding the Tertiary terrestrial faunas of Patagonia, very little is known about the contemporaneous terrestrial floras. In 1899 Dusén described [1] a small and rather poor collection of plants of Tertiary age from what he called the Fagus and Araucaria zones from several localities on both sides of the Strait of Magellan, and in 1925 I described [2] a rather well preserved collection from Chubut Territory which appeared to have come from the so-called Santa Cruz formation.

LOCALITIES

The present collections came from the following five localities—three in Rio Negro Territory and two in Santa Cruz Territory—and the only information I have regarding them is contained on the labels accompanying them. The Rio Negro localities are all in the vicinity of Lago Nahuel Huapi, and with the collectors numbers are:

176. Folded tuffs 4 km. west southwest of Bernal (4 leagues southeast of Barriloche);

[1] Dusén, P., Svenska Exped. Magellansländerna, vol. 1, No. 4, 1899.
[2] Berry, Edward W., Johns Hopkins University Studies in Geology, No. 6, 1925.

196. Tuff (thin bedded SS) on axis of anticline, 2½ leagues above embouchеur of canyon of Rio Nirihuao into basin of Lago Nahuel Huapi; and

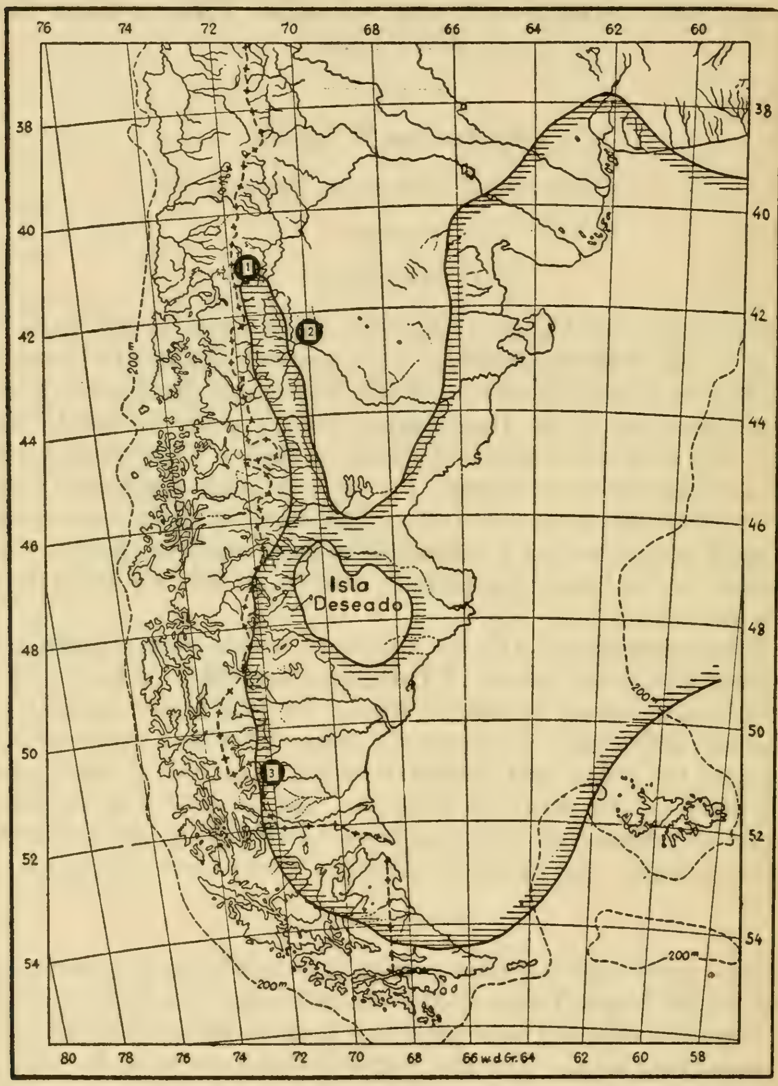

FIG. 1.—LOCALITIES IN LAGO NAHUEL HUAPI REGION, RIO NEGRO TERRITORY; 2. LOCALITY OF MIRHOJA, CHUBUT TERRITORY; 3. LOCALITIES IN RIO CHALIA REGION, SANTA CRUZ TERRITORY

198. Southeast side of Rio Nirihuao, 1½ leagues above foot of canyon, 150 yards southwest of Casa Piedra (4 leagues south of Lago Nahuel Huapi).

The two Santa Cruz localities are:

112. (One league north of Estancia Chalia) (Bob. Lively's place in lot 77), Rio Chalia; and

116. (Bluff ½ league south of Mata Amarilla, upper Rio Chalia.) The age of the last is given as Santa Cruzian?

FLORA

A total of 27 different forms are more or less satisfactorily identified and 19 of these appear to be new. They comprise 22 genera in 17 families and 14 orders, and represent 4 ferns, 1 cycad, 2 conifers, 1 monocotyledon, and 19 dicotyledons. None except form genera have furnished more than a single species and no families except the Polypodiaceae and Monimiaceae are represented by more than a single species.

The largest number of forms identified from any single locality is but 9. There are 16 species recorded from the Rio Negro localities and 11 from the Rio Chalia localities. None are common to the two; even the genera are all different, and they appear to be different in age as well as in the environmental conditions which they indicate.

The three Rio Negro localities have but one species common to two of them, so that they may not be of exactly the same age, but the data are insufficient to affirm or deny this, and I am considering them collectively as affording certain contrasts with the two Rio Chalia localities.

These three localities in Rio Negro Territory are all in the vicinity of Lago Nahuel Huapi and apparently from what Roth called the Piso de Nahuel Huapi. They have yielded the following florule:

Alsophila antarctica.
Pteris nirihuaoensis.
Filicites sp. 1.
Filicites sp. 2.
Zamia australis.
Araucaria nathorsti.
Scirpites sp.
Fagus (?) subferruginea.
Nothofagus simplicidens.
Leguminosites calliandraformis.
Leguminosites sp.
Anacardites (?) patagonicus.
Myrcia nitens.
Phyllites nirihuaoensis.
Phyllites mollinediaformis.
Phyllites sp. (cf. *Schinopsis*).

This florule is too small for any accurate ecologic estimate; nevertheless the *Zamia* is the only form that is far removed from its present-day range, and *Zamia* occurs abundantly in the lower Miocene coal measures of the Arauco district in Chile, where, however, it is associated with much warmer types. A comparison with the flora described from Mirhoja, Chubut Territory, nearly 2° farther south, shows no common species between the two and none of the mesophytic warm types of the latter, so that the present florule must be considered to be a distinctly cooler temperate flora. Compared with

the existing flora of the Lago Nahuel Huapi district, it shows no certain indications of different temperature conditions but does seem to indicate considerable more humidity and an environment more like that found at the present time west of the Andes in Chile. If this conclusion is valid, it would mean less extremes of temperature throughout the year as compared with present conditions in Rio Negro Territory.

The florule from the two localities in the Rio Chalia district of western Santa Cruz Territory includes the following 11 species:

Adiantum patagonicum.
Fitzroya tertiaria.
Rollinia (?) patagonica.
Hydrangea (?) incerta.
Sterculia washburnii.
Peumus clarki.
Laurelia amarillana.
Laurophyllum chalianum.
Apocynophyllum chalianum.
Bignonites chalianus.
Phyllites sp. 6 (?).

Although occurring about 8° farther south, it comprises a much more northern and warmer climate assemblage than the previous florule, *Fitzroya* being the only species that seems distinctly at home in this latitude at the present time and then only in the wet environment of the Chilean side of the Andes. One species, *Peumus clarki*, and several genera are common to the flora described from Mirhoja, Chubut Territory, and point to the present flora as having lived in a humid warm temperate environment.

INDICATIONS OF AGE

From what has been said in the preceding paragraphs, both the genera represented and the environment which they indicate point to these florules being of different ages. So much seems perfectly clear. Whether either or both should be considered Oligocene or Miocene is not so clear. The whole general question of the age of the Patagonian sedimentaries has given rise to a remarkable diversity of opinion, the principal contributors having been Ameghino, Roth, Gaudry, Scott, Hatcher, Ortmann, von Ihering, Wilckens, Cossmann, Wiman, Windhausen, and Matthew. The statement by the last-named author [3] is one of the most recent and the most useful summary.

In a recent paper Schiller [4] mentions well-preserved dicotyledonous leaves near Barriloche overlain by tuffs partly silicified, from which he enumerates 25 species of marine mollusca representing the Patagonian stage. From this there is some reason for supposing that

[3] Matthew, W. D., in Climate and Evolution. Annals N. Y. Acad. Sci., vol. 24, pp. 171–318, 1915.

[4] Schiller, W., El Cerro "Ottoshöhe" de Bariloche. Bol. Acad. Nac. d. Ciencias Argentina, vol. 30, pp. 335–339, 1927.

the three plant localities in the Lago Nahuel Huapi region are older than the Patagonian marine beds. This coincides with my former and present conclusions based upon a study of all available evidence, although, as has been frequently pointed out, this evidence is far from complete.

In former contributions[5] I have considered Dusén's Fagus zone to be upper Eocene or lower Oligocene, since it occurs below the marine Magellanian, and his Araucaria zone to be upper Oligocene, since it occurs above the Magellanian and below the Patagonian.[6] The second might be lower Miocene, but since its flora is so unlike the lower Miocene floras of Chile I have thought it to be older.

Table of distribution

	Rio Negro Territory			Santa Cruz Territory		Mirhoja, Chubut Territory	Arauco District, Chile	Straits of Magellan	Seymour Island, Antarctica
	Locality 176	Locality 196	Locality 198	Locality 112	Locality 116				
Alsophila antarctica	----	×	----	----	----	----	----	----	×
Adiantum patagonicum	----	----	----	×	----	----	----	----	----
Pteris nirihuaoensis	×	----	×	----	----	----	----	----	----
Filicites species 1	×	----	----	----	----	----	----	----	----
Filicites species 2	×	----	----	----	----	----	----	----	----
Zamia australis	----	----	×	----	----	----	----	----	----
Araucaria nathorsti	×	----	----	----	----	----	----	×	----
Fitzroya tertiaria	----	----	----	×	----	----	----	----	----
Scirpites species	----	----	×	----	----	----	----	----	×
Fagus subferrunginea	×	----	----	----	----	----	----	×	----
Nothofagus simplicidens	----	----	×	----	----	----	----	×	----
Rollinia (?) patagonica	----	----	----	----	×	----	----	----	----
Hydrangea (?) incerta	----	----	----	----	×	----	----	----	----
Leguminosites calliandraformis	----	×	----	----	----	----	----	----	----
Leguminosites species	----	----	×	----	----	----	----	----	----
Anacardites (?) patagonicus	----	----	×	----	----	----	----	----	----
Sterculia washburnii	----	----	----	----	×	----	----	----	----
Peumus clarki	----	----	----	----	×	×	----	----	----
Laurelia amarillana	----	----	----	----	×	----	----	----	----
Laurophyllum chalianum	----	----	----	×	----	----	----	----	----
Myrcia nitens	×	----	----	----	----	----	×	×	?
Apocynophyllum chalianum	----	----	----	×	----	----	----	----	----
Bignonites chalianus	----	----	----	×	----	----	----	----	----
Phyllites nirihuaoensis	----	----	×	----	----	----	----	----	----
Phyllites mollinediaformis	----	----	×	----	----	----	----	----	----
Phyllites species (cf. Schinopsis)	----	----	×	----	----	----	----	----	----
Phyllites species 6	----	----	----	----	?	----	----	----	×

If the Araucaria and Fagus zones of Dusén have any stratigraphic validity, then the florule from the Lago Nahuel Huapi region is to be correlated with these zones, since as the accompanying table of

[5] In First Pan Pacific Congress Proc., pt. 3, pp. 845–865, 1921.

[6] According to the sections given by Hatcher and Nordenskiöld.

distribution shows 4 of the 16 species are identical with forms described by Dusén from these zones in the Straits of Magellan region and two additional are identical with forms described by this author from the Seymour Island Tertiary, the present occurrence representing their most northern known range. This may be stated in another way by saying that in the time immediately preceding the Patagonian transgression a humid and fairly cool temperature flora extended between 41° and 54° south latitude. Since I regard the Patagonian transgression as corresponding approximately to the Burdigalian stage of the European Miocene, it would mean that the Lago Nahuel Haupi fossil flora should be correlated with the lowest Miocene or the Oligocene of the Northern Hemisphere. Although denominated cool temperate, it is clear from its great north and south range and its possible extension to Antarctica that the climate at that time differed from that of the present in its greater uniformity and relative greater mildness in the far south.

The florule found at two localities on the upper Rio Chalia is markedly distinct from the other, not only in representing entirely different genera but in lacking any species common to the Araucaria or Fagus zones. It has, moreover, a species common to the Santa Cruz (?) flora of Mirhoja in Chubut Territory. As already mentioned, the plants have their modern relatives far to the northward of their fossil occurrence, and the leaves are individually much larger than any in the Rio Negro florule. They thus represent an occurrence of warm temperate types in latitude 49° south. Hatcher describes lower Patagonian marine beds from the upper Rio Chalia, and, so far as chronologic terms are concerned, there is little choice between the terms Patagonian and Santa Cruz, since I believe the latter, although partly contemporaneous with the Patagonian, extends upward to a somewhat later time.

Although the evidence is far from conclusive, it points to this florule being considerably younger than the other, and to its early Miocene age. The location of both this and the earlier florule are shown on the accompanying sketch map, the base of which is Windhausen's map, showing the marine transgression of the Patagonian. I have also indicated the location of the Santa Cruz (?) plant locality at Mirhoja in Chubut Territory.

It will be noted that the localities in the vicinity of Lago Nahuel Huapi, which I regard as belonging to the pre-Patagonian Araucaria and Fagus zones, lie in an area which was transgressed by the marine waters of the long gulf depicted by Windhausen, that the localities on the upper Rio Chalia are interbedded in its marginal deposits, and that the Mirhoja locality, which I referred to the Santa Cruz, lies to the eastward of the Patagonian Gulf and was presumably a low-lying

country. If the map is correct the geography would favor warm currents from the Atlantic and the land barrier would temper Antarctic influences. We know that there was a corresponding submergence of the Chilean littoral at this time, and there is no evidence of high mountains on the site of the Andes, which is also negatived by the floral evidence of equability and humidity.

DESCRIPTIONS OF SPECIES

Order POLYPODIALES

Family CYATHEACEAE

Genus ALSOPHILA R. Browne

ALSOPHILA ANTARCTICA Christ (?)

Alsophila antarctica CHRIST in DUSÉN, Schwed. Südpolar-Exp., vol. 3, Lief. 3, p. 14, pl. 3, fig. 11, 1908.

This species was described for Dusén's account of the Tertiary plants from Seymour Island, Antarctica, by Professor Christ of Basel, who considered it most like the existing *Alsophila féeana* and *A. corcovadensis* of southern Brazil. A single fragment in the present collection is identical with the illustration of the Seymour Island type except that it is slightly smaller, and as it is sterile it might as well be considered to represent the genus *Polypodium*.

Occurrence.—Two and one-half leagues above emboucheur of the canyon of Rio Nirihuao into the basin of Lago Nahuel Huapi, Territory of Rio Negro.

Plesiotype.—Cat. No. 37851, U.S.N.M.

Family POLYPODIACEAE

Genus ADIANTUM Linnaeus

ADIANTUM PATAGONICUM, new species

Plate 1, Figures 5–7

There are more or less complete specimens of four pinnules in the collection, the largest and most complete being the one shown in Figure 5; a second is only about half the size of the former. Pinnules stipitate, nearly orbicular in outline, divided nearly symmetrically by narrow pointed sinuses into four principal (two terminal and two lateral) lobes and the lateral lobes more or less bisected. The distal margins are undulate. Terminal sinus widest and deepest, extending three-fourths of the distance to the base of the lamina,

the adjacent lobes being inequilaterally cuneate. Lateral sinuses similar but only about half as deep. The small sinuses dividing the lateral lobes into two unequal lobules narrow, acutely pointed, and shallow. Stipe flat, with broad band of aggregated vascular bundles down the middle; length, 1.3 centimeters. Lamina ranging in length from 1.25 to 2 centimeters in length and from 1.75 to 3 centimeters in maximum width. Texture subcoriaceous. Venation dichotomous, diverging as a double dichotomy in the decurrent base of the lamina, forking successively as shown in Figure 6. The veins are relatively stout but have the appearance of being immersed in the substance of the lamina. None of the specimens are distinctly fertile, but in places the distal margin shows a decidedly thickened carbonized border, as shown in Figure 7, which may represent fructifications. Some probability is furnished this interpretation, since no such thickening is shown along the distal margin of the upper right-hand lateral lobe. In most of the specimens the distal margins are more or less frayed and do not permit any checking of these features, which, while not exactly as in living *Adiantums*, are suggestively similar.

The genus contains upwards of 100 widely distributed existing species in the warmer parts of the world and extending southward to Chile, Paraguay, and Argentina, in some cases (*A. concinnum* Humboldt, Bonpland, and Kunth) over nearly 40° of latitude, so that they can not be said to be especially influenced by temperature differences. In general, the existing species are less lobate and less equilateral than the fossil, but in the absence of more representative material showing pinnules from different parts of a frond the validity of these apparent differences can not be evaluated. About a score of Cretaceous and Tertiary species have been referred to *Adiantum*, including the quite dissimilar *Adiantites borgóniana* Engelhardt[7] from the Miocene of Lota, Chile. Among somewhat similar existing species the following may be mentioned: *Adiantum chilense* Kaulfuss of Chile, *A. pensile* Kunze of Brazil, *A. tenerum* Swartz of Mexico and the Antilles to Peru, and *A. concinnum* Humboldt, Bonpland, and Kunth which ranges from Central America to Chile. Perhaps as similar a recent form as any is the old world *Adiantum capillus-veneris* of Linnaeus.

Occurrence.—About 3 miles north of Estancia Chalia, Rio Chalia, Territory of Santa Cruz.

Holotype and paratypes.—Cat. No. 37852, USNM.

[7] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 16, Heft 4, p. 644, pl. 2, figs. 6–9, 1891.

Genus PTERIS Linnaeus

PTERIS NIRIHUAOENSIS, new species

Plate 1, Figures 3, 4

Based upon small fragments of pinnae, habit of frond consequently unknown. Pinnae linear-lanceolate, divided nearly to the rachis into relatively long linear, ultimately pointed segments. The sinuses are usually nearly symmetrically rounded and narrower than the segments, but in some instances in maximum-sized fragments the proximal lower margin of the segment is decurrent for a considerable distance, subtending a space wider than the width of the segments. The rachis is stout, prominent, and somewhat flexuous. Margins entire, but faintly undulate. Texture subcoriaceous. Midveins of the segments diverge from the rachis alternately at wide angles and continue to the tips of the segments. They give off at acute angles numerous laterals, the distal of which are simple subtended by once forked laterals and these in turn by twice forked laterals. This typical venation is not constant, however, for in a great many instances there are cross connections resulting in a reticulate venation, as shown in the accompanying figure.

The largest fragment seen is that shown in Figure 3 and is of a sterile pinnule. All of the specimens are much broken and distorted, but what I have considered to represent a piece of a fertile pinna is shown in Figure 4. This is slightly smaller than the sterile, but agrees with it in form and venation. What I take to represent a marginal indusium with its contained sori is a thick crust of carbonaceous matter along the margins of the segments. I could not develop any spores or structural features in this thickened mass, and it may simply represent revolute margins. However, its appearance is significantly like fertile fragments of *Pteris*, and I have given this feature considerable weight in the identification of the fossils.

The vegetative habit, as incompletely determinable from the present fossils, is shared among a large number of fern genera, among which I might mention *Phegopteris*, *Goniopteris*, *Dryopteris*, *Cyathea*, and *Gleichenia* as genera likely to occur in the Patagonian Tertiary. All of these differ in having inframarginal sori and the venation is not reticulate in *Dryopteris* (restricted), *Cyathea* or *Gleichenia* (used in a supergeneric sense). *Phegopteris* sometimes shows a similar reticulate venation, but it is more regular, as it is also in those species of *Goniopteris* which are reticulate.

Many species of *Pteris* have the form of the fossil, and a similarly reticulate venation occurs in widely scattered forms in Asia and New

Zealand, as well as in Central and South America. This in combination with the supposed fertile specimens agree in pointing to *Pteris* as the genus to which the fossil should be referred. A large and rather questionable *Pteris* has been recorded by Engelhardt from the Arauco coal measures (Miocene) of Chile.[8]

Occurrence.—Folded tuffs 4 km. west southwest of Bernal, about 12 miles southeast of Barriloche, Lago Nahuel Huapi, and southeast side of Rio Nirihuao near Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Cotypes.—Cat. Nos. 37853, 37854, U.S.N.M.

Genus FILICITES Schlotheim

FILICITES species 1

Plate 1, Figure 1

Represented by the single fragment figured, showing a linear pinnule with central midvein and numerous thin subparallel laterals diverging from the midvein at wide angles. The material is too incomplete and poorly preserved to admit of its identification. The margin appears simple, but it may have been finely toothed. The laterals appear simple, but they may have occasionally been dichotomous. Naturally, resemblances could be pointed out to numerous unrelated fern genera. The fossil is perhaps most like the pinnules of the existing and wide-ranging *Gleichenia* (*Dicranopteris*) of South America.

Occurrence.—Four km. west southwest of Bernal, 12 miles southeast of Barriloche, Lago Nahuel Huapi, Territory of Rio Negro.

Cat. No. 37855, U.S.N.M.

FILICITES species 2

Plate 1, Figure 2

A poorly preserved fragment of a fern pinna with short pinnulate lobes, rather coriaceous texture, and faint venation. The tips of the segments are frayed and may have been more elongate than they are depicted.

This fern is undeterminable. It resembles a fragment from the Tertiary of Seymour Island, Graham Land, which Dusén[9] called *Pecopteris* species 1. It might well be a Dryopteris.

Occurrence.—Four km. west-southwest of Bernal, 12 miles southeast of Barriloche, Lago Nahuel Huapi, Territory of Rio Negro.

Cat. No. 37856, U.S.N.M.

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[8] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 16, Heft 4, p. 643, pl. 2, figs. 1–4, 1891.

[9] Dusén, P., Schwed. Südpolar-Exped., vol. 3, Lief. 3, p. 19, pl. 4, fig. 5, 1908.

Order CYCADALES

Family CYCADACEAE

Genus ZAMIA Linnaeus

ZAMIA AUSTRALIS, new species

Plate 2, Figure 1

Frond tiny, ovate lanceolate in outline, about 5.5 centimeters long and 1.4 centimeters in maximum width, consisting of about 32 pairs of subopposite to alternate pinnules. Pinnules oriented at angles of about 65° to the rachis, to the top surface of which they are united by the whole width of their bases. They are entire, strictly linear in outline, and conspicuously truncate at their tips. Their texture is coriaceous and their few veined longitudinally parallel venation is very faint, possibly because the specimens show only the upper surface of the frond. That it is the upper surface seen and that the pinnules are attached to the upper surface of the rachis is shown by the fact that the bases of the pinnules nearly meet and the outline of the broader rachis can be made out beneath their proximal edges.

This characteristic little form is one of the most interesting in the whole collection. It is based upon two nearly complete specimens and represents the southernmost known extent of the genus in either the past or the present.

The genus *Zamia*, whose species are not at all genetically related to numerous fossil forms that have been described as species of *Zamites*, contains about 35 existing species, ranging from peninsular Florida, Mexico, and the Antilles through northern South America and along the eastern and in that region wetter Andean slopes to eastern Bolivia and northwestern Argentina.

Zamia is the dominant existing cycad genus of the Western Hemisphere, and its range in the Tertiary was greater than at present, extending to latitude 36° 30′ north in the Eocene.[10] A South American Pliocene species was recorded by Krasser [11] from Bahia, Brazil, but was not represented in the collections which I obtained from the same locality. A splendid species occurs in the Arauco coa fields (Miocene) of Chile.[12] This last is much larger and quite different from the present form, which is very similar to the small species of Florida with underground stem.

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[10] Berry, Edward W., Torreya, vol. 16, pp. 177–179, figs. 1–3, 1916.

[11] Krasser, F., Sitz. k. Akad. Wiss. Wien, vol. 112, ab. 1, p. 853, 1903.

[12] Berry, Edward W., Johns Hopkins Studies in Geology, No. 4, p. 120, pl. 1, fig. 4; pl. 2, figs. 1–3, 1922.

The existing southern limit of *Zamia* is about 25° south latitude, the Chilean Miocene occurrence is about 38° south, and the present is in about latitude 41° 30′ south, thus over 6½° south of the existing range.

Occurrence.—Southeast side of Rio Nirihuao, near Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Holotype.—Cat. No. 37857, U.S.N.M.

Order ARAUCARIALES

Family ARAUCACEAE

Genus ARAUCARIA Jussieu

ARAUCARIA NATHORSTI Dusén

Plate 2, Figures 5, 6

Araucaria nathorsti Dusén, Svensk. Exped. till Magellansländerna, vol. 1, No. 4, p. 105, pl. 12, figs. 1–13, 1899.

This species was described by Dusén from the lignitic shales near Punta Arenas, where it is so abundant that this horizon was christened the Araucaria stage. Dusén distinguishes between the leaves of sterile and fertile twigs, the latter being usually larger, broader, and more ovate (triangular of Dusén), with a broader decurrent base.

The smaller leaf figured is identical with Dusén's, Figures 5 or 11, but the larger, which predominate in the present collection, are larger and more produced pointed than any he has figured and have more veins than the smaller leaf. The smaller have 12 to 13 veins and the larger about twice as many. While inclining to doubt the possibility of assigning the detached fossil leaves to sterile or fertile shoots, I see no reason to doubt that the present collection represents the same species as that described from the Straits of Magellan.

Dusén compared the fossil with the existing Chilean pine, *Araucaria imbricata* Pavon, and the similarity is as close as might be expected. If the two occurrences are identical in representing *Araucaria nathorsti*, this species ranges from about 53° south to nearly 41° south, or over nearly 12° of latitude, and this is in accord with the numerous occurrences of petrified wood of the Araucarioxylon type which has been reported by many explorers in various parts of this region. The fossil differs from the existing *Araucaria brasiliana* in its more coriaceous texture, in which respect it is much more similar to *Araucaria imbricata*, differing from both in the less contracted base.

Although both belong to the Colymbea section of the genus, it differs from *Araucaria araucoensis* Berry [13] in its much larger and inferentially more crowded leaves, which also differ in outline and in the width at the basal flexure.

Araucaria imponens described by Dusén [14] from the Tertiary of Seymour Island, Antarctica, has much the general form of the larger leaves from Rio Negro Territory with a wide base, but is more distinctly lanceolate and has fewer veins—not very constant or important features. Its describer considers the Antarctic species to be closer to *Araucaria brasiliana* than to *Araucaria imbricata;* but as it is represented by very meager material, there is little basis for an opinion.

Occurrence.—Four km. west southwest of Bernal, about 12 miles southeast of Barriloche, Territory of Rio Negro.

Plesiotypes.—Cat. No. 37858, U. S. N. M.

Order PINALES

Family CUPRESSINACEAE

Genus FITZROYA Hooker f.

FITZROYA TERTIARIA, new species

Plate 2, Figures 2–4

Leafy twigs, slender, branching; covered with ovate, pointed, appressed, imbricated leaves, with broadly decurrent bases. The phyllotaxy can not be determined, but as the leaf points usually rise to different levels the effect is of a spiral phyllotaxis, whatever the arrangement at their insertion may have been. (*F. patagonica* is said to have the leaves in alternate trimerous whorls.) These leaves are flat or convex with the contour of the twigs and not keeled; some are slightly divergent, and perhaps a majority have recurved tips, but the habit is much more appressed than in the single specimen of *Fitzroya patagonica* that has been available for comparison. In some fragments where the plant substance is preserved it is seen to be coriaceous and shows traces of a wide but not prominent midvein as in the recent species.

Although only sterile twigs have been seen and no microscopial preparations have been made there is little doubt but that these

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[13] Berry, Edward W., Johns Hopkins Studies in Geology, No. 4, p. 122, pl. 3, figs. 1–4, 1922.

[14] Dusén, P., Wiss. Ergeb. Schwed. Südpolar-Exped. 1901–1903, vol. 3, Lief. 3, p. 11, pl. 1, figs. 16, 17, 1908.

twigs represent the genus *Fitzroya*. Their place of occurrence and associates point to this conclusion, as do the correspondence in size of leaves, in their broad decurrent bases and general form and midvein. They are commonly somewhat more pointed than the leaves of the small amount of recent material seen and are also more appressed. The species is said to show considerable variability in the degree of crowding or spreading of the leaves.

The genus is an interesting one, the modern distribution of which has suggested that it was a relict genus, but no fossil species have heretofore been described, to my knowledge. There is also some difference of opinion regarding its position among the Coniferales. It has usually been associated with the Actinostrobinae—all of whose members have a unique disconnected range—but it is by some authors [15] removed from association with *Actinostrobus*, *Callitris*, and *Widdringtonia* and referred to the Cupressinaceae. *Fitzroya patagonica* is a mesophytic type of the Chilean temperate rain forest, reaching its northern limit at about latitude 40° near Valdivia and extending southward nearly to the end of South America, overlapping slightly the western frontier of Argentina and southern Patagonia, where the environment is suitable. It is a large tree and reaches its largest size in palustrine environments.

A second species confined to Tasmania was described by Hooker in the monotypic genus *Diselma*. It has usually been considered to belong to the same genus as the Chilean tree, but recently it has been proposed to revive the genus *Diselma* for its reception. The question is one involving a great deal of personal equation, and whichever view finally prevails, there can be no doubt of the similarity and probable relationship between the two.

Occurrence.—About 3 miles north of Estancia Chalia, Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37859 U.S.N.M.

Class MONOCOTYLEDONAE

MONOCOTYLEDONAE INCERTAE SEDIS

SCIRPITIS species Dusén (?)

Plate 3, Figure 15

Scirpitis species Dusén, Schwed. Südpolar-Exped., vol. 3, Lief, 3, p. 16, pl. 2, fig. 6, 1908.

The coarseness of the parallel veins and the lack of a midvein stamp these remains as stem fragments. They vary considerably in size, the fragment figured being the largest seen. As far as one may

[15] Seward, A. C., Fossil Plants, vol. 4, p. 124, 1919.

judge from figures, this is identical with what Dusén considered to represent a *Scirpus*-like sedge from the Tertiary of Seymour Island, Antarctica.

Obviously, little reliance can be placed upon this similarity, since both occurrences represent a type which might have been present in this region at any time from the Upper Cretaceous to the present and which could scarcely be expected to show differential characters.

Occurrence.—Southeast side of Rio Nirihuao near Casa Piedra, 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Cat. No. 37860 U.S.N.M.

Class DICOTYLEDONAE

Order FAGALES

Family FAGACEAE

Genus FAGUS Linnaeus (?)

FAGUS SUBFERRUGINEA Dusén

Fagus subferruginea DUSÉN, Svenske Exped. Magellansländerna, vol. 1, No. 4, p. 94, pl. 8, figs. 1–8, 1899.

This species was described by Dusén from near Punta Arenas and Barancas de Carmen Sylva in the Magellan Strait region. It is represented by a number of specimens in the present collection. I can see no valid reason for referring it to *Fagus* instead of *Nothofagus*. It is larger than the majority of leaves of *Nothofagus* and does resemble the leaves of the European beach; but occurring as it does in a profuse occurrence of *Nothofagus*, it is most unlikely to represent the northern genus.

Occurrence.—Four kilometers west southwest of Bernal, 12 miles southeast of Barriloche, Lago Nahuel Huapi, Territory of Rio Negro.

Cat. No. 37861, U.S.N.M.

Genus NOTHOFAGUS Blume

NOTHOFAGUS SIMPLICIDENS Dusén

Plate 2, Figures 7–9

Nothofagus simplicidens DUSÉN, Svenske Exped. till Magellansländerna, vol. 1, No. 4, p. 100, pl. 9, figs. 20–25, 1899.

This species was named—it can hardly be said to have been described—by Dusén in 1899. His material was abundant and came from the following localities in the vicinity of the Strait of Magellan: Barancas de Carmen Sylva, Rio Beta, Rio Condor, Bagnales, and near Punta Arenas.

Leaves, small, subcoriaceous, ovate in general outline, with an acute apex and a slightly inequilateral cuneate base. Margin with somewhat variable but invariably simple and relatively large teeth, one to each secondary. These teeth are prevailingly dentate, from which they grade into serrate, and some specimens approach what might be called crenate-serrate. Length ranging from 1.75 to 3.5 centimeters. Maximum width ranging from 0.75 to 1.5 centimeters. Petiole stout, usually missing, but preserved in one specimen to a length of 3.5 millimeters. Secondaries 10 to 12 pairs, opposite to alternate, thin, straight, subparallel or slightly divergent, craspedodrome, usually ascending at angles of about 45°, but subtending somewhat greater angles in the smaller and relatively wider forms. Tertiaries percurrent. Aerolation obsolete.

The genus *Nothofagus* comprises about 17 existing austral species, confined to southern Chile, Patagonia, and Tierra del Fuego in the Western Hemisphere and to southern Australia, Tasmania, and New Zealand in the Eastern Hemisphere. According to Skottsberg (1915), the recent species are distributed as follows: 6 in New Zealand, 1 in Tasmania, 1 in Tasmania and Victoria, 1 in New South Wales, and 8 in South America. The genus is divided into evergreen and deciduous sections. The deciduous species comprise 1 in Tasmania and 5 in South America. The evergreen section contains 3 in South America, all 6 of the New Zealand species, 1 in Tasmania and Victoria, and 1 in New South Wales. They are obviously related to *Fagus* of the Northern Hemisphere and for a long time were referred to that genus. *Fagus* has been recorded as a fossil associated with *Nothofagus* in South America, Australia, and New Zealand, but it may be questioned if the two can be separated on the basis of leaf form alone. Several forms resembling *Nothofagus* have been found in the Tertiary of Europe, but are equally unreliable. Recently Bandulska [16] has described a *Nothofagus* from the Eocene of southern England, basing her determination upon the cuticular-structure which she claims to be able to differentiate from that of *Fagus*.

A large number of fossil species have been described from the Tertiary of the regions where the living species occur; at least two occur on Seymour Island, Antarctica.[17] In considering the 13 species and varieties which Dusén has described from the Tertiary of Patagonia and Tierra del Fuego, one is impressed with the thought that perhaps the majority of these are the slightly varying leaves of a much fewer number of botanical species.

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[16] Badulska, H., Journ. Linn. Soc. Bot., vol. 46, p. 433, pl. 39, fig. 20, 1924.

[17] Dusén, P., Wiss. Ergeb. Schwed. Südpolar-Exped. 1901–1903, vol. 3, Lief. 3, p. 10, pl. 1, figs. 10, 12, 19; pl. 3, figs. 7–9, 1908.

The present species is not uncommon in the collection studied. In the existing flora *Nothofagus* extends northward on the wetter Chilean side of the Andes to about latitude 33°.

Occurrence.—Southeast side of Rio Nirihuao near Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Plesiotypes.—Cat. No. 37862, U.S.N.M.

Order RANALES

Family ANONACEAE

Genus ROLLINIA St. Hiliare (?)

ROLLINIA (?) PATAGONICA, new species

Plate 2, Figure 11

Leaves of small size, ovate-elliptical in outline, widest medianly, with a narrowly rounded apex and a cuneate base. Margins entire. Texture subcoriaceous. Venation obsolete, due to carbonization of the lamina during fossilization. Length about 4.5 centimeters. Maximum width about 2.25 centimeters. Petiole short and stout, between 5 and 6 millimeters in length. Midvein straight, relatively stout and prominent. Secondary and tertiary venation not visible.

It is rather hazardous to attempt an identification of this leaf as representing the genus *Rollinia.* It agrees rather well with the existing *Rollinia parvifolia* of northeastern Argentina. The genus has about a score of existing species of shrubs and trees in the warmer parts of South America. A single fossil species not very different from the present form has been described from the Pliocene of eastern Brazil.[18]

Occurrence.—Bluff about 1½ miles south of Mata Amarilla, Upper Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37863, U.S.N.M.

Order ROSALES

Family SAXIFRAGACEAE

Genus HYDRANGEA Linnaeus (?)

HYDRANGEA (?) INCERTA, new species

Plate 5, Figure 2

Leaf oval in general outline, with a rounded apex and a truncate or broadly cuneate base, widest below the middle. Margins somewhat

[18] Hollick and Berry, Johns Hopkins Studies in Geology, No. 5, p. 52, pl. 2, fig. 4, 1924.

irregularly sublobate. Texture coriaceous. Length about 5 centimeters. Maximum width about 3.5 centimeters. Midvein stout. Secondaries 4 or 5 irregularly spaced pairs, diverging from the midvein at varying angles, camptodrome.

The identity of this incomplete leaf is exceedingly problematical, and it may possibly represent some member of the Bignoniaceae. Both alternatives are represented in the existing flora of northern Argentina. *Hydrangea* is an ancient genus, cosmopolitan in existing floras and with several well-defined Tertiary species in the Northern Hemisphere, represented in Patagonia by *Hydrangeiphyllum affine* Dusén.[19]

Occurrence.—One and one-half miles south of Mata Amarilla, upper Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37864, U.S.N.M.

LEGUMINOSAE INCERTAE SEDIS

Genus LEGUMINOSITES Bowerbank

LEGUMINOSITES CALLIANDRAFORMIS, new species

Plate 3, Figures 13, 14

This species is based upon the single specimen figured, obviously representing a leaflet of some member of the alliance Leguminosae.

Leaflet small, very inequilaterally obovate. Apex broadly rounded, but slightly unsymmetrical. Base sessile, markedly inequilaterally cuneate. Margin entire. Texture subcoriaceous. Length about 11 millimeters. Maximum width about 5 millimeters. Midvein stout, much curved. Secondaries thin, ascending, curved, camptodrome; three from the extreme base, a slender one inside the midvein, and two coarser ones outside the midvein.

This leaflet is much like those of the genus *Calliandra* Bentham, which contains over 100 existing species, the majority in the warmer parts of South America. Two fossil species have been described from the Pliocene of Potosí, Bolivia. Since similarly veined leaflets occur in *Cassia*, *Caesalpinia*, and other genera of this alliance, and since the present material is so limited, it is referred to the form genus Leguminosites.

Occurrence.—Canyon of Rio Nirihuao, 2½ leagues above its emboucheur in the basin of Lago Nahuel Huapi, Territory of Rio Negro.

Holotype.—Cat. No. 37865, U.S.N.M.

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[19] Dusén, P., Svenska Exped. till Magellansländ, vol. 1, No. 4, p. 102, pl. 10, fig. 5, 1899.

LEGUMINOSITES species

Plate 3, Figure 17

Leaflet small, inequilaterally subelliptical, with about equally rounded apex and base. Margins entire. Length about 9.5 millimeters. Maximum width, above the middle, about 3.5 millimeters. Petiolule stout, curved, about 1 millimeter in length. Midvein not prominent. Balance of venation obscure. This obviously represents some member of the Leguminous alliance, but it affords no reliable generic features, and is therefore referred to the form genus Leguminosites.

Occurrence.—Southeast side of Rio Nirihuao, 150 yards southwest of Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Cat. No. 37866, U.S.N.M.

Order SAPINDALES

Family ANACARDIACEAE

Genus ANACARDITES Saporta (?)

ANACARDITES (?) PATAGONICUS, new species

Plate 5, Figure 1

This is one of those leaves that is not especially characteristic. Its sessile base and slightly falcate outline suggest that it may represent a leaflet of a pinnate leaf. I identify it with considerable hesitation as a leaflet of some member of the Anacardiaceae which contains several South American genera similar to the fossil.

Medium-sized, ovate-falcate in outline, widest medianly, with an acute tip and a slightly inequilateral more narrowed, sessile base. Margins entire. Texture subcoriaceous. Length about 5.5 centimeters. Maximum width about 1.75 centimeters. Midvein stout, prominent and curved. Secondaries thin, numerous, subparallel, camptodrome.

The generic name used was proposed by Saporta for leaflets of this family whose generic assignation was uncertain. A score of species have been described from the Tertiary of North America and Europe. Fossil species in South America have been found in Trinidad and Brazil.

Occurrence.—Southeast side of Rio Nirihuao. 150 yards southwest of Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Holotype.—Cat. No. 37867, U.S.N.M.

Order MALVALES

Family STERCULIACEAE

Genus STERCULIA Linnaeus

STERCULIA WASHBURNII, new species

Plate 4, Figures 1–7

Since these leaves are variable and abundant at a single outcrop, I have considered that they represent a single species of *Sterculia*, a genus whose leaves are notoriously variable as to form and lobation. It may be described as follows:

Leaves variable in size and form, palmately three to five lobed. Lobes ovate with rounded tips or conical with acute tips. Sinuses openly rounded, shallow or extending about halfway to the base. Base ranging from decurrent to cuneate to truncate, depending on the number and attitude of the lobes, which may be directed obliquely upward or laterally. Petiole long and exceedingly stout, in one specimen preserved for a length of 3 centimeters. Margins entire. Texture coriaceous. Length ranging from 4 to 8 centimeters. Maximum width ranging from 2.5 to 8 or more centimeters. Primaries three, stout, diverging from the base, or subbasal in some of the forms with a decurrent base, diverging at acute angles. In the five-lobed forms the lateral primaries give off a short distance above their base a stout lateral which runs to the tip of the lower lateral lobe. Secondaries thin, camptodrome. Tertiaries thin, simple and percurrent, or flexed medianly, or sometimes forked medianly.

Named for the collector, Chester W. Washburne. This species has the general features of leaves of this genus, which first appear in considerable abundance in mid-Cretaceous floras of various parts of the world. The genus is common in the warmer parts of South America, at the present time ranging southward to the Argentine Mesopotamia (about latitude 30°). A second fossil Argentine species, not unlike but perfectly distinct from *Sterculia washburnii*, has been described from the supposed Santa Cruz beds of Chubut Territory.[20]

Occurrence.—Bluff about 1½ miles south of Mata Amarilla, upper Rio Chalia, Territory of Santa Cruz.

Cotypes.—Cat. No. 37868, U.S.N.M.

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[20] Berry, Edward W., Johns Hopkins Studies in Geology, No. 5, p. 220, pl. 9, figs. 5, 6, 1925.

Order LAURALES

Family MONIMIACEAE

Genus PEUMUS Persoon

PEUMUS CLARKI Berry

Plate 2, Figure 10

Peumus clarki BERRY, Johns Hopkins Studies in Geology, No. 6, p. 204, pl. 5, fig. 2, 1925.

This species was described from the supposed Santa Cruz beds of Mirhoja, Chubut Territory. The specimen from Santa Cruz territory is similar to the type in every respect except that it is slightly narrower, in consequence of which the sessile base is more acute.

The genus is monotypic in the existing flora of Chile, ranging, as an evergreen tree, from about latitude 30° to latitude 42°. The present fossil occurrence carries its range much farther south and extending it over nearly 7° of latitude in Argentina. In this connection it is possible that the leaf from the Tertiary of Seymour Island, Antarctica, described by Dusén[21] as *Phyllites* species (2), may represent a second fossil species of Peumus.

Occurrence.—Bluff about 1½ miles south of Mata Amarilla, upper Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37869, U.S.N.M.

Genus LAURELIA Jussieu

LAURELIA AMARILLANA, new species

Plate 5, Figure 3

Leaf broadly lanceolate in outline, widest medianly and about equally pointed at the apex and the base. Base narrowly cuneate and decurrent. Margin entire for its basal third, above which it has somewhat irregularly and widely spaced undulate-crenate teeth. Texture coriaceous. Length about 6 centimeters. Maximum width about 2.5 centimeters. Petiole stout, 7 to 8 millimeters in length. Midvein stout, prominent on the under side of the leaf. Secondaries about 5 alternate pairs, diverging from the midvein at acute angles, thin, long ascending, inclined to be somewhat flexuous, camptodrome, but sending branches into the marginal teeth. Areolation obsolete, a few tertiaries seen, as shown in the illustration.

This greatly resembles the existing Chilean *Laurelia aromatica* Sprengel in all of its features. The genus contains three species in

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[21] Dusén, P., Wiss. Ergeb. Schwed. Südpolar-Exped., vol. 3, Lief. 3, p. 16, pl. 1, fig. 15, 1908.

the existing flora, one in New Zealand and the other two in Chile in the region between 36° and 42° south latitude. If botanical systematists are correct in their opinion that these belong to the same genus, then we are bound to presuppose that it had a geological history unless we are prepared to subscribe to the once fashionable but now absurd notion that a genus can originate more than once and in different areas. Excluding the highly problematical fossil forms from the Northern Hemisphere which have been referred to *Laurelia*, a fossil species has been described by Dusén [22] from the Tertiary of Seymour Island, Antarctica.

This is a somewhat fragmentary specimen of a larger size, with less ascending secondaries and more pointed teeth than *Laurelia amarillana*, and also less similar to the existing *Laurelia aromatica*.

Occurrence.—Bluff one-half league south of Mata Amarilla, upper Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37870, U.S.N.M.

Family LAURACEAE

Genus LAUROPHYLLUM Goeppert

LAUROPHYLLUM CHALIANUM, new species

Plate 5, Figure 4

Leaves elongate-lanceolate, widest below the middle, with an extended gradually narrowed tip and a more abruptly acute base. Margins entire. Texture subcoriaceous. Length about 9 to 10 centimeters. Maximum width about 1.5 centimeters. Midvein stout, somewhat flexuous, prominent on the under side of the leaf. Secondaries thin, numerous, diverging from the midvein at acute angles, long ascending, eventually camptodrome. Tertiaries obsolete.

This species is represented by several incomplete specimens and is evidently Lauraceous. As it is impossible to determine its generic position with certainty, it is referred to the form genus *Laurophyllum*. It may represent the genus *Nectandra*, although similar leaves occur in several existing Lauraceous genera of the warmer parts of South America.

A typical species of *Nectandra* is present in the supposed Santa Cruz beds of Chubut Territory,[23] so that this genus is known to have ranged farther south during the Tertiary than it does at the present time.

Occurrence.—Three miles north of Estancia Chalia, Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37871, U.S.N.M.

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[22] Dusén, P., Schwed. Südpolar-Exped., vol. 3, Lief. 3, p. 4, pl. 1, fig. 5, 1908.

[23] Berry, Edward W., Johns Hopkins University Studies in Geology, No. 5, p. 224, pl. 8, fig. 1, 1925.

Order MYRTALES

Family MYRTACEAE

Genus MYRCIA De Candolle

MYRCIA NITENS Engelhardt

Plate 3, Figures 1–9

Myrcia (*Cryptomyrcia*) *nitens* ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 16, Heft 4, p. 679, pl. 10, fig. 7, 1891.

Myrtiphyllum bagualense DUSÉN, Svenska Exped. till Magellansländ., vol. 1, No. 4, p. 103, pl. 11, figs. 7–9, 1899.

This species was described by Engelhardt from the lower Miocene of Coronel, Chile. It is exceedingly abundant in all sizes in the present collection, and the larger leaves (such as those shown in figs. 7–9) are identical in every respect with Engelhardt's Chilean type. With these, and grading to much smaller but otherwise similar leaves, are a series of forms identical with those from southern Patagonia which Dusén described as *Myrtiphyllum bagualense.* Every gradation of size is represented in the present collection, and there can be no doubt but that a single botanical species is represented. It might possibly be argued that Dusén's, which come from over 11° farther south, were normally smaller, because of the possibly more severe climatic conditions. Among the leaves recorded by Dusén [24] from the Tertiary of Seymour Island, Antarctica, there is an apical fragment (*Phyllites* species 16) which very probably represents this same species.

Occurrence.—Four km. west southwest of Bernal, 12 miles southeast of Barriloche, Lago Nahuel Huapi, Territory of Rio Negro.

Plesiotypes.—Cat. No. 37872, U.S.N.M.

Order GENTIANALES

Family APOCYNACEAE

Genus APOCYNOPHYLLUM Unger

APOCYNOPHYLLUM CHALIANUM, new species

Plate 5, Figure 5

Leaf oblong, acutely pointed at the apex and base. Margins entire. Texture coriaceous. Length about 11 centimeters. Maximum width about 3.25 centimeters. Petiole stout, about 2.25 centimeters in length. Midvein stout, prominent. Secondaries thin, numerous, diverging from the midvein at wide angles, subparallel, ending in an acrodrome marginal vein parallel with and close to the leaf margins.

[24] Dusén, P., Schwed. Südpolar-Exped., vol. 3, Lief. 3, p. 18, pl. 2, fig. 10, 1908.

This form somewhat resembles *Myrcia costatoides* Engelhardt [25] of the lower Miocene of Chile, but is much larger and stouter with a much longer petiole. It does not conform to the features of any Myrcias with which I am familiar. There are, of course, leaves of this general type in various unrelated existing genera. Some figs have similar leaves, e. g., the existing *Ficus pulchella* Schott, but the venation is not quite the same and the inframarginal vein is usually farther within the margins and arched from secondary to secondary.

Somewhat similar leaves occur in various Myrtaceae and Guttiferae, but the type is especially characteristic of a considerable number of genera of the Apocynaceae and can be exactly matched among existing species of *Plumiera* and *Allamanda*. For these reasons I feel justified in referring it to the form genus *Apocynophyllum*.

Nothing of this kind was found in the supposed Miocene flora from Mirhoja, Territory of Chubut.[26] All of the existing genera with leaves like the fossil find their home in the warmer parts of South America, and none extend farther southward than northern Argentina.

Occurrence.—About 3 miles north of Estancia Chalia, Rio Chalia, Territory of Santa Cruz.

Cotypes.—Cat. No. 37873 U.S.N.M.

Order PERSONALES

Family BIGNONIACEAE

Genus BIGNONITES Saporta

BIGNONITES CHALIANUS, new species

Plate 5, Figure 6

Leaflets of medium size, ovate, widest medianly and about equally pointed at the apex and base. Margins entire. Texture subcoriaceous. Length about 7 centimeters. Maximum width about 3.5 centimeters. Midvein stout, prominent. Secondaries about 5, mediumly stout camptodrome pairs; the basal pair are stoutest and opposite and run close to and parallel with the lower lateral margins to the middle of the leaf, simulating lateral primaries. Tertiaries thin, usually forming a double series of meshes between adjacent secondaries.

This form presents features allying it with various existing genera of Bignoniaceae of the existing flora in the warmer parts of South America. Several genera range southward as far as northern Argentina.

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[25] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 16, Heft 4, p. 680, pl. 9, fig. 6, 1894.

[26] Berry, Edward W., Johns Hopkins University Studies in Geology, No. 5, pp. 185–252, pls. 1–9, 1922.

Occurrence.—Three miles north of Estancia Chalia and 1½ miles south of Mata Amarilla, upper Rio Chalia, Territory of Santa Cruz.

Holotype.—Cat. No. 37874, U.S.N.M.

DICOTYLEDONAE INCERTAE SEDIS

PHYLLITES NIRIHUAOENSIS, new species

Plate 3, Figures 18, 19

Leaf or leaflet tiny, orbicular in outline, with large irregular crenate teeth. Length 6 millimeters. Maximum width 4.5 millimeters. Apparently sessile. Venation relatively enormously stout and prominent. Midvein flexuous, terminating in an apical tooth. Secondaries 3 or 4 on each side, alternate, stout, often forking, recurving as marginal veins in the teeth. Areolation irregular and mostly rectangular, gradually diminishing in strength.

This typical form is based on the single specimen figured. It is somewhat similar to a slightly larger fragment from Barancas de Carmen Sylva, recorded by Dusén as *Escaloniiphyllum* species.[27] The venation suggests a relationship with the Cunoniaceous genus *Weinmannia*, but this resemblance does not warrant a decision.

Occurrence.—Southeast side of Rio Nirihuao, 150 yards southwest of Casa Piedra and about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Holotype.—Cat. No. 37876, U.S.N.M.

PHYLLITES MOLLINEDIAFORMIS, new species

Plate 3, Figure 16

Leaf small lanceolate, coriaceous, with toothed margin and craspedodrome secondaries. Based on the single specimen figured and possibly representing a narrow *Nothofagus*. Shows considerable resemblance to *Mollinedia seymourensis* Dusén[28] of Tertiary of Seymour Island, Antarctica.

Occurrence.—Southeast side of Rio Nirihuao, 150 yards southwest of Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Holotype.—Cat. No. 37877, U.S.N.M.

PHYLLITES species (cf. SCHINOPSIS)

Plate 3, Figures 10 to 12

More or less complete specimens of small linear-lanceolate leaves or leaflets are not uncommon at this locality. They do not show suf-

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[27] Dusén, P., Svenska Exped. Magellansländerna, vol. 1, No. 4, p. 102, pl. 11, fig. 5, 1899

[28] Dusén, P., Schwed. Südpolar-Exped., vol. 3, Lief. 3, p. 4, pl. 1, fig. 18, 1908.

ficiently characteristic features to warrant even a surmise as to their botanical affinity. They may be briefly characterized as follows: Outline linear lanceolate, widest medianly, acutely and about equally pointed at the apex and base. Margins entire. Texture relatively coriaceous. Length 4 to 5 centimeters. Maximum width 2.75 to 7 millimeters. Petiole stout, about 3 millimeters in length. Midvein mediumly stout. Balance of the venation obscure; a few thin oblique camptodrome secondaries can be made out, thus ruling out comparisons with members of the family Myrtaceae, which are represented in most South American Tertiary floras, including that described from the supposed Santa Cruz beds of the Territory of Chubut.[29] They might represent the leaflets of some Sapindaceous genus, and they are also not unlike those of the Anacardiaceous genus *Schinopsis*, which is represented by good material from the Miocene of Chubut.[30]

Occurrence.—Southeast side of Rio Nirihuao, 150 yards southwest of Casa Piedra, about 12 miles south of Lago Nahuel Huapi, Territory of Rio Negro.

Cat. No. 37878, U.S.N.M.

PHYLLITES species 6 Dusén (?)

Phyllites, sp. 6. Dusén, Schwed. Südpolar Exped., vol. 3, lief. 3, p. 18, pl. 1, fig. 3, 1908.

A specimen indistinguishable from the one recorded by Dusén from the Tertiary of Seymour Island, Antarctica, but too fragmentary to be reliable, is present in the collection from near Mata Amarilla, upper Rio Chalia, Territory of Santa Cruz. Cat. No. 37879, U.S.N.M.)

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[29] Berry, Edward W., Johns Hopkins University Studies in Geology, No. 6, p. 225, pl. 2, fig. 6, 1925.

[30] Idem, p. 208, pl. 1, fig. 2.

EXPLANATION OF PLATES

PLATE 1

FIG. 1. *Filicites* species 1.
2. *Filicites* species 2.
3. Sterile, and Fig. 4. Fertile pinna of *Pteris nirihuaoensis*, new species × 3.
5–7. *Adiantum patagonicum*, new species.
5. The most nearly complete specimen found.
6. Same, slightly restored, × 4.
7. Enlarged segment of distal margin showing supposed sori.

PLATE 2

FIG. 1. *Zamia australis*, new species.
2–4. *Fitzroya tertiaria*, new species.
2. Natural size.
3 and 4. Enlarged × 5.
5, 6. *Araucaria nathorsti* Dusén.
7–9. *Nothofagus simplicidens* Dusén.
10. *Peumus clarki* Berry.
11. *Rollinia* (?) *patagonica*, new species.

PLATE 3

FIGS. 1–9. *Myrcia nitens* Engelhardt.
10–12. *Phyllites* species (cf. *Schinopsis*).
13, 14. *Leguminosites calliandraformis*, new species 14 enlarged × 4.
15. *Scirpites* species Dusén (?)
16. *Phyllites mollinediaformis*, new species.
17. *Leguminosites* species.
18, 19. *Phyllites nirihuaoensis*, new species 19 enlarged × 10.

PLATE 4

FIGS. 1–7. *Sterculia washburnii*, new species.

PLATE 5

FIG. 1. *Anacardites* (?) *patagonicus*, new species.
2. *Hydrangea* (?) *incerta*, new species.
3. *Laurelia amarillana*, new species.
4. *Laurophyllum chalianum*, new species.
5. *Apocynophyllum chalianum*, new species.
6. *Bignonites chalianus*, new species.

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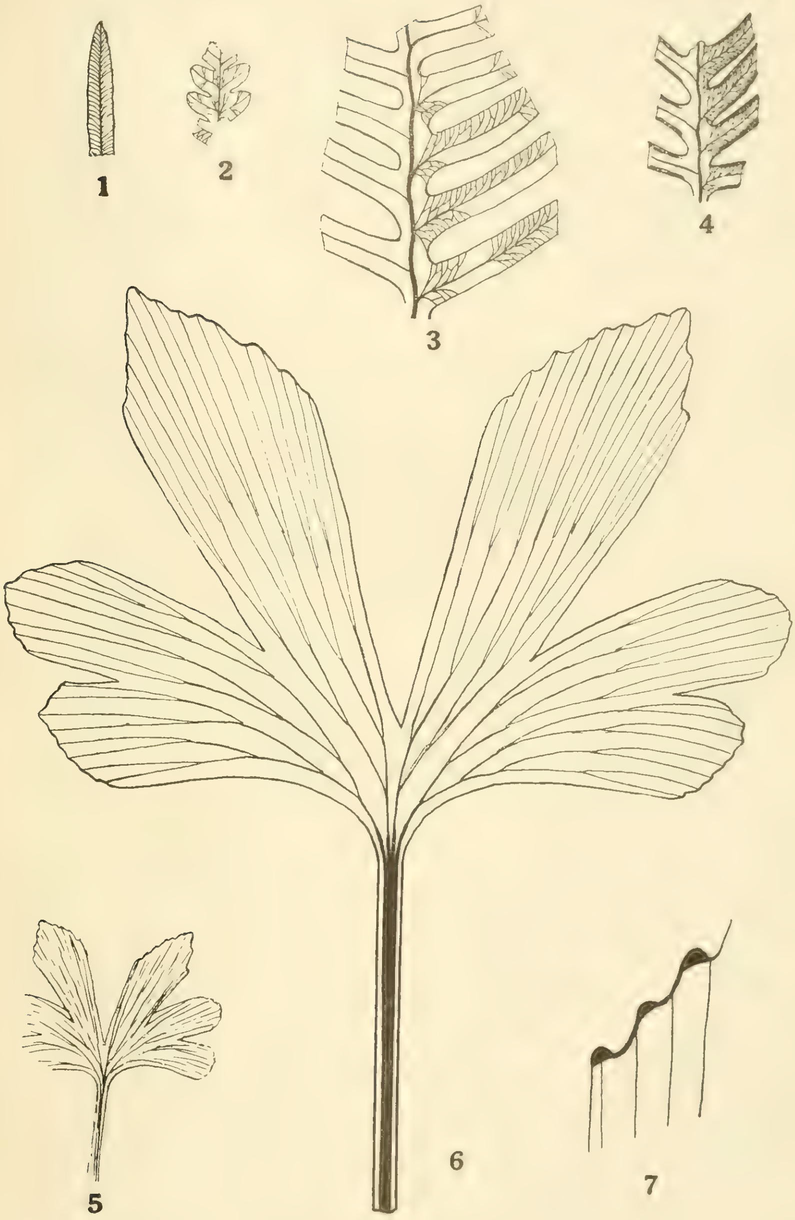
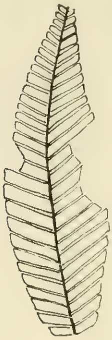


ARGENTINE TERTIARY PLANTS

FOR DESCRIPTION OF PLATE SEE PAGE 27



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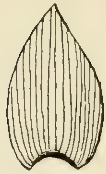

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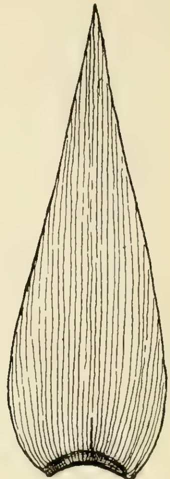

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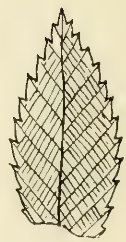

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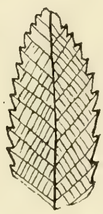

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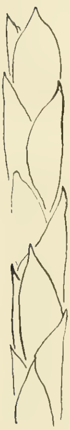

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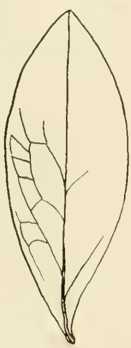

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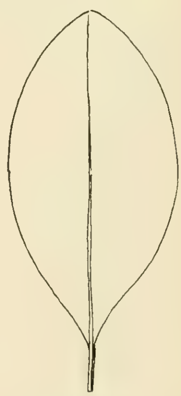

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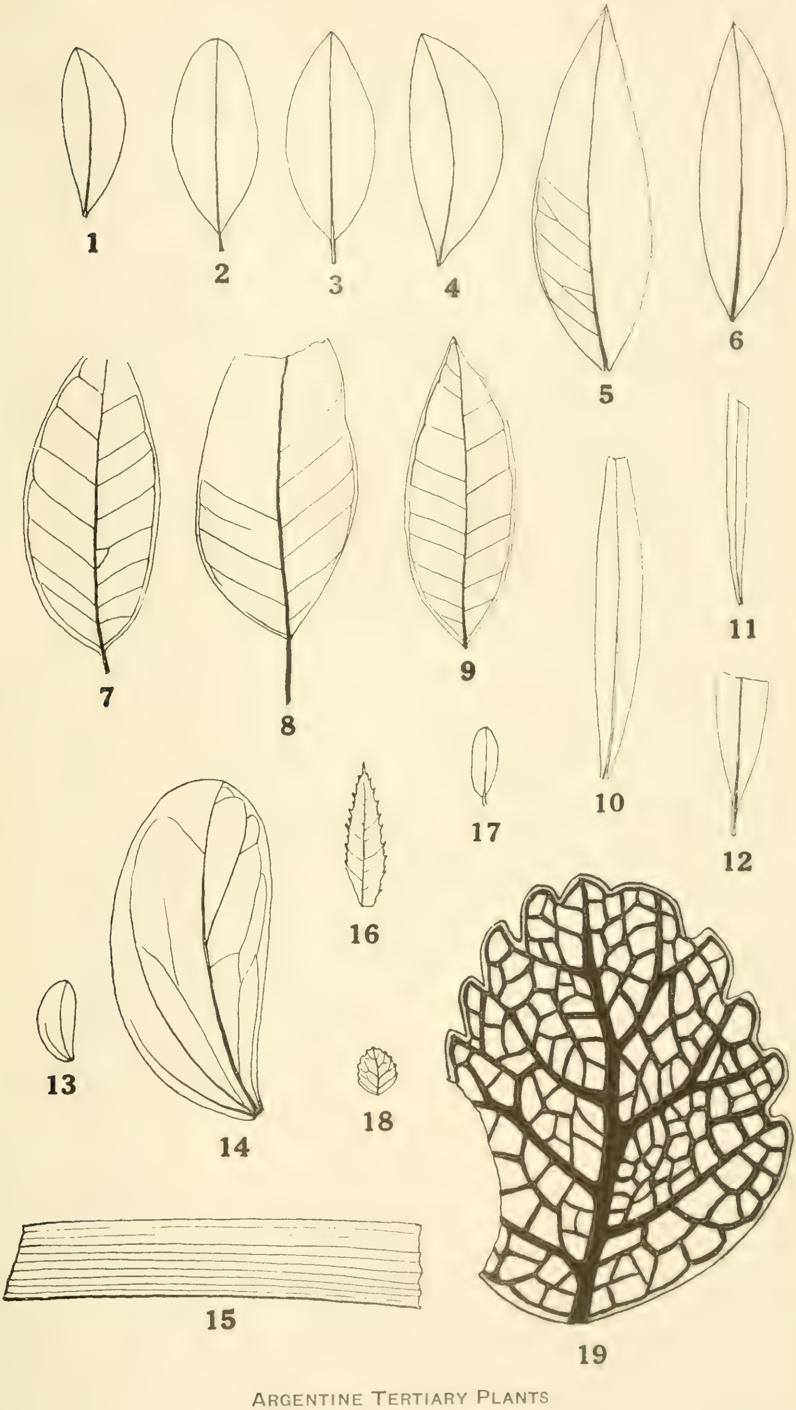
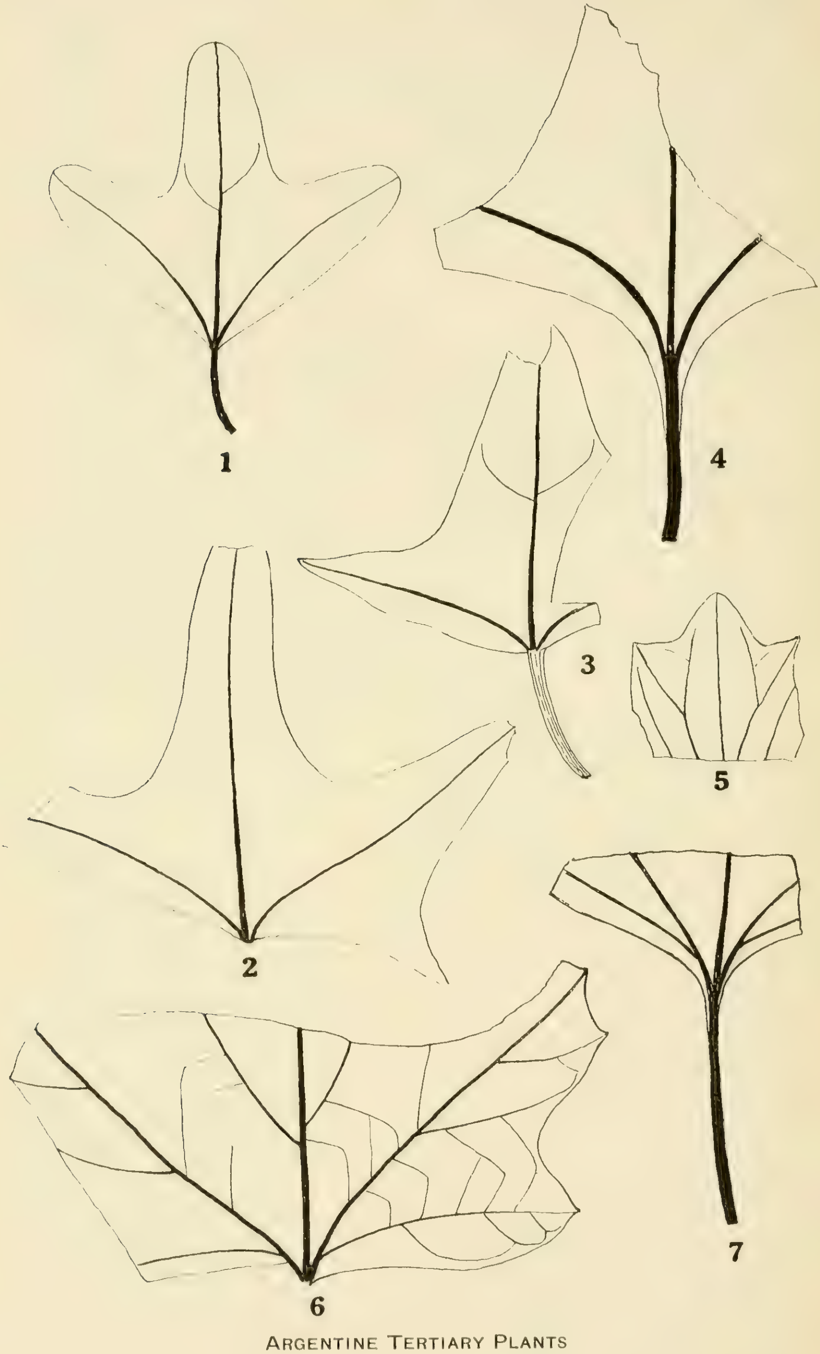
ARGENTINE TERTIARY PLANTS

FOR DESCRIPTION OF PLATE SEE PAGE 27



ARGENTINE TERTIARY PLANTS

FOR DESCRIPTION OF PLATE SEE PAGE 27



ARGENTINE TERTIARY PLANTS

FOR DESCRIPTION OF PLATE SEE PAGE 27

ARGENTINE TERTIARY PLANTS

FOR DESCRIPTION OF PLATE SEE PAGE 27

NOTES ON AMERICAN TWO-WINGED FLIES OF THE FAMILY SAPROMYZIDAE

By J. R. Malloch

Of the Biological Survey, United States Department of Agriculture

Through a coincidence Dr. F. Hendel and the present writer recently published papers[1] dealing with South American Sapromyzidae. Doctor Hendel included all the genera of the family known to him, while I dealt only with South American species. As some of the new genera erected contain species which are not rare, it is not remarkable that several synonyms resulted, and those which I am certain of are noted below.

Genus NEOMINETTIA Hendel

This generic name was proposed by both authors (Malloch, p. 9), and *contigua* Fabricius was cited as genotype by both. As Hendel's paper antedates mine, the genus should be credited to him.

Genus DRYOMYZOTHEA Hendel

My genus *Dryomyzoides* is the same as this, but my genotype, *advena* Malloch, is apparently distinct from his, *setinervis* Hendel.

Genus DEUTOMINETTIA Hendel

This genus was erected for a species, *pulchrifrons* Hendel, which has most of the characters of *Minettia* Robineau-Desvoidy, differing in having the scutellum haired on the disk. I have before me a species which is evidently referable to the genus; and though the face is a little more convex than in normal *Minettia*, it is not so much so that I would place it in the group with markedly convex face. I have not seen the genotype, so can not say whether it has the mid tibia with well-developed bristles on the posterior surface; but if it has, and its similarity to the other included species leads me to believe so, it might be better to base the generic distinction on

[1] Hendel, Encyclopédie Entomol., Diptera, vol. 2, pp. 103–142, 1925, and Malloch, Proc. U. S. Nat. Mus., vol. 68, art. 21, pp. 1–35, 1926.

the presence of these rather than on the form of the face and the setulose scutellum. In this case the genus would contain the genotype and four species known to me—*frontalis* Macquart, *assimilis* Malloch, *geniseta* Malloch, and the species described below. Only the genotype and the last of these have the scutellum haired on the disk, and these two and *frontalis* have the frons with a pair of velvety black marks in front. However *pulchrifrons* may not have mid tibial setulae.

I present below a key for the separation of the above-mentioned species and the new one described herein.

KEY TO THE SPECIES OF DEUTOMINETTIA

1. Frons with two black marks in front; scutellum in some species with distinct setulose hairs on disk in addition to the four marginal bristles----------2
   Frons yellow, unspotted; scutellum with the disk bare, only the four marginal bristles present----------4
2. Wings without dark markings----------bimaculata, new species.
   Wings with distinct dark markins----------3
3. Only the third wing vein dark at apex; disk of scutellum setulose. pulchrifrons Hendel.
   Costal margin dark brown, more broadly so from opposite inner cross vein to beyond apex of fourth vein, the dark color on apices of third and fourth veins narrowly divided by a longitudinal hyaline streak inwardly, both cross veins broadly dark brown, fifth vein faintly clouded; disk of scutellum bare----------frontalis Macquart.
4. Cross veins of wings very distinctly clouded----------5
   Cross veins of wings almost imperceptibly clouded----------geniseta Malloch.
5. Costa without an apical suffusion; mid tibia with about three rather long posterior bristles; hind femur with at least one evident preapical anteroventral bristle----------assimilis Malloch.
   Costa with a trace of an apical suffusion; mid tibia with about seven short posterior setulae; hind femur without an evident preapical anteroventral bristle----------approximata, new species.

Should the presence of scutellar setulae be considered as the distinctive generic character, the four species lacking these would then require to be placed in a separate genus, but the absence or presence of similar hairs has not been considered as sufficient grounds for the erection of genera in related families such as Helomyzidae.

A careful examination of Hendel's description of his genus *Allominettia* and its genotype, *maculatifrons* Hendel, leads me to conclude that this is the same species which I have identified as *frontalis* Macquart.[2] Hendel's specimens came from Peru, while those I had came from Costa Rica. He makes no mention of the mid tibial bristles, but there is nothing remarkable in that, as this character has been ignored by all writers who have dealt with the family until the appearance of my recent papers on the Oriental species of *Homoneura sens. lat.* As indicated in my previous paper,

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[2] Hist. Nat. Dipt., vol. 2, pt. 3, p. 346, from Brazil.

definite decision as to the identity of Macquart's species may depend upon the discovery of his type.

DEUTOMINETTIA APPROXIMATA, new species

Male.—Glossy fulvous yellow, the center of frons shining; antennae and palpi yellow. Both cross veins of wings distinctly, but not broadly, clouded, costa apically slightly suffused with brown.

Anterior orbital bristles over half as long as posterior pair; ocellars minute; postverticals long; arista plumose; face almost flat, glossy, orbits whitish dusted. Thoracic bristles long and strong, anterior sternopleural very short and fine. Mid tibia with about seven short posterior bristles; mid femur without anteroventral bristles. Inner cross vein a little beyond middle of discal cell.

Length, 6 mm.

One male, Trinidad River, Panama, May 2, 1911 (A. Busck).

Type.—Cat. No. 40965, U.S.N.M.

DEUTOMINETTIA BIMACULATA, new species

Male and female.—Testaceous yellow, distinctly shining. Orbital stripes glossy, ceasing at anterior orbitals, a velvety deep black mark on each side from anterior orbital to anterior margin of frons which extends posteriorly, forming a wedge-shaped mark between orbit and eye almost as far as posterior bristle; parafacials silvery. Abdomen with a faint dark apical line on each tergite in male. Legs yellow. Wings hyaline. Halteres yellow.

Frons slightly widened anteriorly, with some microscopic surface hairs, all bristles long and strong; arista plumose; face slightly bulging out over mouth, a little convex; eye narrowed below, slightly emarginate on lower half behind; two strong bristles on lower part of occiput. Thorax with three postsutural dorsocentrals, about eight series of introdorsocentral hairs, the intra-alar strong, disk of scutellum black setulose, and the anterior sternopleural bristle very weak. Fore femur without an anteroventral comb; all tibiae with preapical dorsal bristle, mid pair each with a series of eight or more distinct posterior setulae. Inner cross vein of wing close to middle of discal cell; apical section of fourth vein but little longer than preceding section; first posterior cell slightly narrowed apically.

Length, 6–7 mm.

One male, Trinidad Rio, Panama, May 1, 1911; allotype and one male paratype, same locality, March 16 to 23, 1912 (A. Busck).

Type.—Cat. No. 40708, U.S.N.M.

Genus ASILOSTOMA Hendel

This genus was erected for the reception of a single species, *enderleini* Hendel, from Bolivia. Before me there is a species undoubt-

edly belonging to this genus, and another which agrees with the general description of the genotype, but differs in the bristling of the vertex and in some other respects. I deprecate the erection of monobasic genera and, as I find included in some related genera species which differ in a similar manner, I do not propose to erect a new genus for the species now before me.

All of the species have the basal and second antennal segments of about the same length, the first haired below, the third not less than six times as long as wide at middle, the arista plumose, face prominently protruded and convex, thorax with two pairs of postsutural dorsocentrals, no presutural (posthumeral), and one sternopleural; scutellum bare, flattened above, and with four bristles. The venation is different in *palpalis* from that of the other species. In three the wings are marked with fuscous, and the second, third, and fourth segments of fore tarsi of all five are compressed.

I present below a key for the identification of the species, the genotype being unknown to me except from the description.

KEY TO THE SPECIES OF ASILOSTOMA

1. Distance from bases of antennae to lower margin of face not half as great as that from bases of antennae to vertex; frons testaceous yellow, except the dark ocellar spot, face concolorous, the lower lateral angles and most of the cheeks glossy black; labrum large, its area almost as great as that of face, glossy black; palpi deep black, and much dilated; anterior pair of orbital bristles about as long as posterior pair, and close to middle of frons. palpalis, new species.

   Distance from bases of antennae to lower margin of face not much less than that from bases of antennae to vertex; frons and face black; labrum narrow; palpi slender---2
2. Anterior pair of orbital bristles not half as long as posterior pair; legs entirely stramineous---3

   Anterior pair of orbital bristles fully as long as posterior pair; legs yellow, fore tibia and fore metatarsus, except apex of latter, black. enderleini Hendel.
3. Frons and face glossy black---pallipes, new species.

   Frons with a large velvety black mark in front, the remainder glossy black---4
4. Face entirely glossy black---atriceps, new species.

   Face and cheeks entirely glossy yellow---flavifacies, new species.

ASILOSTOMA PALPALIS, new species

Male.—Head shining testaceous yellow, ocellar spot, a large mark on each side of upper half of frons, and the lower lateral angle of face and contiguous portion of each cheek, black; upper side of basal segment of antennae, and the third segment except base fuscous; palpi black, arista yellow, the hairs brownish. Thorax and abdomen brownish yellow, a dark streak over each humerus, and a velvety black vitta along upper half of pleura and sides of abdomen.

Legs testaceous yellow, a mark on apices of fore femora, another near bases of fore tibiae, and the fore metatarsi except their apices, black, the dilated portion of fore tarsi whitish. Wings marked with fuscous as in Figure 2.

Frons fully twice as long as wide, the surface uniform in texture; ocellars miscroscopic; cheek almost linear; face concave below antennae, the lower half prominently convex (fig. 1); third antennal segment about seven times as long as its width at middle. Thorax appearing finely granulose on dorsum, with two or three closely placed series of miscroscopic intradorsocentral hairs, and a series of similar hairs in line with each series of dorsocentrals; prescutellar acrostichals lacking. Fore femur without bristles or anteroventral

FIGS. 1–2.—1. HEAD OF ASILOSTOMA PALPALIS FROM SIDE. 2. WING OF ASILOSTOMA PALPALIS

comb; tibiae with the preapical dorsal bristle very short except on mid pair. Venation as in Figure 2.

Length, 5.5 mm.

One male, Barro Colorado, Panama Canal Zone, July 27, 1923 (R. C. Shannon).

Type.—Cat. No. 40710, U.S.N.M.

ASILOSTOMA PALLIPES, new species

Female.—Head glossy black, antennae testaceous, third segment black except extreme base; aristae and the hairs, except those on basal half on upper side, white; palpi fuscous. Thorax colored as in *palpalis*, but without black markings. Abdomen brownish black. Legs entirely pale yellow. Wings marked with fuscous as in Figure 3. Halteres yellow.

Frons a little longer than wide, posterior orbitals about middle of frons, and fully twice as long as anterior pair; antennae as in *palpalis;* face but slightly concave below antennae, and quite prominently convex below, much as in genotype, the labrum narrow, cheek about as high as width of third antennal segment. (Fig. 4.) Thorax not so long as in *palpalis*, the anterior pair of dorsocentral bristles much

nearer to suture, and the intradorsocentral hairs farther apart. Fore femora with two or three fine posteroventral bristles. Venation as in Figure 3.

Length, 3.5 mm.

One female, Trinidad Rio, Panama, March 23, 1912 (A. Busck).

Type.—Cat. No. 40709, U.S.N.M.

ASILOSTOMA ATRICEPS, new species

Female.—Head black, upper portion of frons to below the upper orbital bristle on sides and to a point a little higher in middle distinctly shining, anterior portion deep velvety black, with a white dusted mark on each margin above level of bases of antennae; face glossy, with a purple tinge; basal two antennal segments testaceous yellow, third fuscous; aristae white, the long hairs at base above dark; palpi fuscous. Thorax pale brown, more or less dusted on dorsum and not noticeably shining except on sides of mesonotum, propleura, scutellum, and metanotum testaceous yellow, a large mark in front

FIGS. 3–4.—3. WING OF ASILOSTOMA PALLIPES. 4. HEAD OF ASILOSTOMA PALLIPES FROM SIDE

of each wing base velvety black. Abdomen brown, shining. Legs pale stramineous, the fore tarsi palest. Wings grayish hyaline, with faint brown clouds along fifth vein, outer cross vein, apex of second vein, and on a short subapical section of third and fourth veins. Halteres yellow.

Vertex with inner pair of bristles long and strong, outer pair lacking, postverticals minute, anterior orbital bristles very small; third antennal segment about six times as long as wide; arista long haired basally above, the hairs decreasing rapidly in length apically, the lower side short haired; face in type damaged, but evidently not so much swollen as in some of the other species. Thorax normal, the two pairs of dorsocentral bristles long and strong. Legs long, fore tarsi thickened. Inner cross vein a little beyond middle of discal cell; second vein slightly arched with costa, third and fourth slightly convergent on apical sections to near apices.

Length 2.75 mm.

One female, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Cat. No. 40954, U.S.N.M.

ASILOSTOMA FLAVIFACIES, new species

Female.—Head as in preceding species but the face and cheeks are honey yellow. The thorax is colored as in *atriceps* but the anterior margin is more yellowish and vittate, and the sternopleura is yellow, not dark, and the dark mark on sides of metathorax is deeper black. Abdomen shining fuscous. Wings with but faint indications of the cloud on fifth vein and outer cross veins, none on apices of other veins.

Structurally similar to *atriceps.*

Length, 3 mm.

Type and one defective paratype, Higuito, San Mateo, Costa Rica (P. Schild.).

Type.—Cat. No. 40955, U.S.N.M.

Genus BLEPHAROLAUXANIA Hendel

This genus has the base of third vein setulose to beyond the inner cross vein, the face convex below, and two pairs of normal backwardly inclined orbitals. The most striking character of the genus is the presence of fine hairs on the upper surface of the third antennal segment which are as long as, or longer than, the width of the segment itself. There is no other genus except the next following one so far described in which such hairs occur.

BLEPHAROLAUXANIA TRICHOCERA Hendel

This is the only known species of the genus, and occurs in Peru. It is a yellow species, with the wing veins mostly browned. The arista is very long haired and the thorax has three pairs of postsutural dorsocentrals.

I have not seen the species.

Genus PLATYGRAPHIUM Hendel

This genus lacks the presutural (posthumeral) bristle, has the third antennal segment three times as long as wide, and long haired on upper surface as in the preceding genus. It differs from that genus in having no presutural bristle, the third wing vein without bristles, and the arista with the hairs about half as long as width of third antennal segment. *Platygraphium penicillatum* Hendel is the only known species, and it is recorded only from Bolivia. It is yellow in color, with the abdomen browned, and has the wings grayish hyaline, with the base and costa yellowish. It is unknown to me.

Genus ERIURGUS Hendel

This genus lacks the presutural bristle, has the wing veins without bristles, and the third antennal segment orbicular and without hairs

above. The distinguishing character is the presence of long fine hairs on the posterior and ventral surfaces of the fore femora and tibiae. *Eriurgus pilimanus* Hendel is the only known species of the genus and occurs in Peru. It is entirely yellow in color and similar in most respects to *Dryomyzothea setinervis* Hendel

The genotype from which the description was made is a male and it is possible the female may not have long hairs on the forelegs.

Genus ALLOMINETTIA Hendel

For discussion of this genus see under *Deutominettia* in this paper.

Genus SCUTOLAUXANIA Hendel

This genus has the scutellum with hairs above, and the stem of veins 2 and 3 setulose as in *Xenochaetina* Malloch. The thorax has two pairs of postsutural dorsocentrals, and the arista is long haired. *Scutolauxania piloscutellaris* Hendel is the only known species of the genus; it occurs in Peru. A yellow species resembling *Allogriphoneura nigromaculata* Hendel except that there are no black spots at apex of the scutellum. It is unknown to me.

Genus RHABDOLAUXANIA Hendel

There are very slight distinctions given for this genus, the principal being the lack of ocellar bristles, and the very strong orbitals, of which the anterior pair is longest. *Rhabdolauxania schnusei* Hendel, is a yellow species, with six dark spots on each wing, the one at apex of second vein being very large. Bolivia and Peru. *Rhabdolauxania laevifrons* Hendel, is a smaller species, with less conspicuously marked wings, the spot at apex of second vein being very small. Peru.

FREYIA, new genus

This genus resembles *Lauxania* Latreille in many respects, but is readily distinguished from it by the much shorter third antennal segment, slightly incurved anterior orbitals, very short ocellars, conspicuous transverse depression below middle of face, lack of presutural (posthumeral) bristle, and the presence of but one pair of postsutural dorsocentrals and no acrostichals. The sixth wing vein is also extremely short, barely extending beyond anal cell. In Hendel's key it runs to *Asilostoma* but it is readily distinguished from it by the shape of the head, presence of but one pair of dorsocentrals, etc.

I dedicate the genus to Dr. R. Frey, who has done some fine work in this and related families of Diptera.

Genotype.—The following species.

FREYIA NIGRITA, new species

Female.—Glossy black, convex upper portion of face brownish yellow, third antennal segment at insertion of arista, and base of latter, yellow; artista apically, and its hairs, white; fore legs with the trochanters, basal two-thirds of femora, and extreme bases of tibia, yellow; mid and hind tibiae and trasi yellow, apices of the tibiae black. Wings yellowish, slightly darker at bases. Knobs of halteres black.

Head in profile as Figure 5; frons uniform in texture, anterior orbitals slightly incurved, almost as long as, but much finer than, posterior pair; basal and second antennal segments equal in length, the former not haired below; hairs on arista rather dense, and about half as long as width of third antennal segment; postverticals rather short; outer verticals about half as long as inner pair. Surface hairs on mesonotum sparse and short; anterior sternopleural weak; scutellum slightly flattened above, rounded in outline, basal bristles shorter than apical pair. Fore legs slightly thickened, the femur with 2–3 bristles on apical half of posteroventral surface and no anteroventral comb; all tibiae with preapical dorsal bristle. Inner cross vein close to middle of discal cell, outer one at fully its own length from apex of fifth vein; penultimate section of fourth vein less than one-third as long as ultimate.

FIG. 5.—HEAD OF FREYIA NIGRITA FROM SIDE

Length, 3 mm. exclusive of antennae.

One female, Higuito, San Mateo, Costa Rica (P. Schild.).

Type.—Cat. No. 40879, U.S.N.M.

Genus HALIDAYELLA Hendel

This generic name was proposed by Hendel as a substitute for *Calliope* Haliday, the latter being preoccupied.

When my previous papers were written I was uncertain of the characters of *Calliope*, and referred the American species *flaviceps* Loew to the genus. Hendel cites *aenea* Fallen as the genotype of *Halidayella*, the sole original species of *Calliope*, *scutellata* Meigen, being a synonym of this; and I have that species, *elisae* Meigen, and *atrocaerulea* Becker, before me now. These species have the face entirely glossy black, distinctly convex on upper half, and with a transverse depression at middle, below which it is almost flat or slightly convex; the thorax has three pairs of strong postsutural dorsocentrals and no intra-alar; and the frons is shining, with the orbits broad, and but poorly distinguished from the interfrontalia. In the males of these species there is a dense patch of short black

setulae at apices of ventral surfaces of the hind tibiae. I have not seen the female of any of the three species.

I have seen no species of the genus from America, so the genus should be deleted from our list.

PSEUDOCALLIOPE, new genus

This genus has the face evenly convex, without a transverse depression near middle; the frons almost uniformly glossy; the arista pubescent; thorax with the anterior one of the three pairs of postsutural dorsocentrals reduced in size, and a short but distinct intra-alar present.

Genotype.—*Lauxania flaviceps* Loew.

The presence of the intra-alar bristle and lack of a transverse impression of face, and a ventral patch of setulae on hind tibia, distinguish the genus from *Halidayella* to which it runs in Hendel's key to the genera of the world.

The species described as *Minettia verticalis* in this paper resembles *flaviceps* in some respects, but the face and frons are not glossy, and the former is not so noticeably convex.

Genus MINETTIA Robineau-Desvoidy

Minettia Robineau-Desvoidy, Myodaires, 1830, p. 646.

I described several species of this genus in the paper already referred to but gave no synoptic key. Doctor Hendel also described a few species in his paper. Below I am presenting a key to the species which I have been able to identify, but there are no doubt many more which are unknown to me, so that care must be exercised in using it for identifications. I omit the North American species which do not occur south of the United States so far as I know.

I have included *Sapromyza schwarzi* Malloch in the key because it may be confused with this genus by those not well versed in the generic distinctions.

KEY TO THE SPECIES OF MINETTIA

1. Face yellow, with at least a black central spot on lower margin; scutellum with a black spot at base of each of the apical bristles, which may sometimes be continued forward toward base of scutellum, forming two dark vittae........2
   Face either black or yellow, if yellow and with a black central spot the scutellum is without black apical spots........8
2. Wings with at most the cross veins slightly clouded, no other markings present........3
   Wings with quite conspicuous dark markings in addition to any on cross veins........6
3. Mesopleura and sternopleura each with a small round black spot; antennae entirely yellow........slossonae Coquillett.
   Pleura with, or without, two partial blackish vittae, no round black spot on the mesopleura........4

4. Palpi and antennae yellow ---------- zebroides Hendel.
Palpi black at apices ---------- 5
5. Antennae entirely yellow; a brown mark on each cheek.
octopunctata Wiedemann.
Basal two antennal segments black, third yellow; no dark mark on cheek, but one on each side of labrum below eye ---------- picticornis Coquillett.
6. Face with a round black spot above middle on each side and one in center of lower margin; a blackish spot on each cheek below eye; basal two antennal segments black ---------- tripuncticeps Malloch.
Face with but one black mark, in center of lower margin; no dark mark on cheek; antennae entirely yellow ---------- 7
7. Thorax with four blackish vittae; a dark mark about middle of apical section of fourth vein ---------- octovittata Williston.
Thorax without dark vittae; no dark spot near middle of apical section of fourth vein, but one at its apex ---------- evittata Malloch.
8. Face yellow, with a black central mark ---------- 9
Face either entirely yellow or entirely black ---------- 10
9. Forelegs and antennae testaceous yellow; thorax usually very faintly vittate.
valida Walker.
Forelegs black from apical third of femora to apices of tibiae; antennae fuscous, base of third segment yellowish; thorax conspicuously quadrivittate with black on dorsum ---------- Sapromyza schwarzi, new species.
10. Scutellum yellow, with a black spot at base of each apical bristle ---------- 11
Scutellum black or yellowish, without evident black apical spots ---------- 14
11. Wings hyaline; mesonotum with four large black spots.
nigripunctata, new species.
Wings partly infuscated; mesonotum without black spots ---------- 13
12. Wing marked almost exactly as in *Neominettia contigua* Fabricius, with two brown spots on third vein between inner cross vein and apex which are connected with the broad brown costal streak, a conspicuous cloud over each cross vein, and one on apex of third vein and another on apex of fourth, the two last connected along costa with the costal cloud.
tucumanensis, new species.
Wing without evident spots on third vein between inner cross vein and apex ---------- 12
13. Wings broadly brown on costal region, the infuscation extending almost to third vein up to a point nearly in line with outer cross vein, and over third vein from there to apex, the fourth and fifth veins not narrowly clouded; abdomen with a central black spot on fourth and fifth tergites, and without conspicuous lateral apical black marks ---------- bipunctata Say.
Wings narrowly dark brown along costa from apex of auxiliary vein to apex of fourth, more broadly so on both cross veins, narrowly brown on third and fourth veins from inner cross vein to apices, and on fifth from near base to apex; abdominal tergites each with a narrow, centrally interrupted, black fascia on apical margin, broadest on sixth tergite, where it forms a large spot on each side, no central black spot present -- tinctinervis Malloch.
14. Thorax black or brownish black; arista long haired ---------- 15
Thorax yellow, sometimes with black spots or vittae; if dark brown the arista is only pubescent ---------- 16
15. Thoracic dorsum velvety black and faintly vittate; scutellum brown on margin and slightly shining; abdomen with white, almost silvery, dust on basal three tergites; only two pairs of dorsocentral bristles on thorax; wings black at extreme bases ---------- argentiventris, new species.

Thorax and abdomen shining black, the former thinly bluish grey dusted, not vittate, scutellum not paler on margin than on disk; two strong, and one very weak, pairs of dorsocentral bristles present behind suture; wings slightly and almost uniformly infuscated, the extreme bases of veins yellowish--infuscata, new species.

16. Wings either largely infuscated or with well-defined dark markings in addition to any that are present over the cross veins--------------------17
Wings hyaline, with at most clouds over the cross veins, and rarely with a slight costal suffusion but no distinct markings; arista plumose---------20

17. Yellow species, with clean-cut markings on the wings; arista short haired-18
Dark brown species, with the wings intensely brown on costa and gradually becoming less dark posteriorly, but with no well-defined markings; arista bare or pubescent---19

18. Thoracic dorsum with two blackish vittae which extend to apex of scutellum, the pleura with two similar vittae, one on upper margin and the other on upper margin of sternopleura; wings marked with black as follows: A costal streak from base extending to over second vein and running obliquely across cross wing to hind margin in second posterior cell covering all of apex of wing, a cloud over inner cross vein, and another over outer one, the latter extending to apex of fifth vein and back along that vein almost to base of discal cell; in the large apical dark portion there are three hyaline spots, one in submarginal cell and two in first posterior cell; legs conspicuously marked with black----------geminata Fabricius.
Thorax entirely yellow; wings each with six large blackish spots, three along costa, all of which extend more narrowly to third vein, the basal one inclosing the inner cross vein, one at apex over tips of veins 3 and 4, sometimes divided into two, one over outer cross vein and one in fifth vein just beyond middle of discal cell; legs yellow, with extreme apices of hind femora black--quadrata, new species.

19. Anterior one of the three pairs of postsutural dorsocentrals distinctly proximid of middle of mesonotum, and distinctly closer to the suture than to the posterior pair; vertex not abnormally setulose.
brunneicosta, new species.
Anterior one of the three pairs of postsutural dorsocentrals distinctly behind the middle of mesonotum, and about as close to posterior pair as to suture; vertex much more strongly and numerously setulose than usual.
verticalis, new species.

20. Cross veins of wings very faintly clouded; species but slightly shining; mid tibia with about seven short regular posterior setulae; hind femur with at least one preapical anteroventral bristle.
Deutominettia geniseta Malloch.
Cross veins of wings quite distinctly infuscated; species distinctly shining--21

21. Costa without any trace of a dark suffusion; mid tibia with about three rather long posterior bristles; hind femur with at least one evident preapical anteroventral bristle---------------Deutominettia assimilis Malloch.
Costa with a slight trace of a dark suffusion apically; mid tibia with about seven short regular posterior setulae; hind femur without an evident preapical anteroventral bristle--------Deutominettia approximata, new species.

NOTE.—I have included in the above key the three species lacking the scutellar setulae and without frontal black spots which I have now placed in *Deutominettia* in this paper as there is some question as to whether they belong to the latter or not. Only a thorough revision of the family by someone who has access to a much larger amount of material than either Hendel or I have will settle the matter of generic limits.

MINETTIA ZEBRA Hendel

This species appears to me to be the same as *tripuncticeps* Malloch, and though the description was evidently published prior to that of the latter the fact that *Minettia zebra* Kertesz was described some years before should bar *zebra* as the name for the American species and validate *tripuncticeps*.

MINETTIA ZEBROIDES Hendel

The description of this species agrees with *picticornis* Coquillett in most particulars but the palpi are given as entirely yellow, which is not the case in that species.

MINETTIA NIGROPUNCTATA, new species

Male and female.—Pale testaceous yellow, with rather dense whitish dusting; antennae and palpi yellow, the thorax with eight large black spots as follows: One at suture laterad of each anterior dorsocentral bristle, one between each posterior dorsocentral and prescutellar acrostichal, one on each side of scutellum occupying the space between the lateral and apical bristle, and one on each mesopleura at base of the bristle. Abdomen with a black central spot on one or two of the apical tergites. Legs yellow. Wings yellowish hyaline. Halteres pale.

Frons a little wider than long, narrowest behind, the orbits hardly differentiated, with the anterior bristle a little shorter than posterior and very slightly incurved at tip, postvertical bristles a little shorter than outer verticals, the latter about half as long as inner pair; ocellars very short and hairlike; no surface hairs on frons; face evenly convex; third antennal segment fully twice as long as wide; arista with its longest hairs about half as long as width of third antennal segment; cheek about half as high as eye. Thorax with three pairs of postsutural dorsocentrals, six series of intradorsocentral hairs, one pair of long prescutellar acrostichals, the intra-alar quite weak, four long scutellars, and one sternopleural; scutellum flattened above. Hypopygium of male quite large, lateral exposed portion about as wide and nearly as long as hind femur. Legs normal, all tibiae with a preapical dorsal bristle, fore femur without anteroventral comb. Inner cross vein a little beyond middle of discal cell; apical section of fourth vein a little over twice as long as preapical; outer cross vein at about its own length from apex of fifth vein.

Length, 3.5 mm.

Type.—Male, allotype, and three paratypes, Bolivia (Germain), in Deutsches Entomologisches Museum.

MINETTIA ARGENTIVENTRIS, new species

Male.—Head brownish black; frons velvety black, more brownish on orbits and a narrow central vitta, and with grayish dust at bases of the bristles; antennae brownish yellow; aristae fuscous, paler at bases; face slightly white dusted; occiput testaceous on each side of lower half, and with whitish dust; palpi fuscous. Thorax deep brownish black, almost velvety on dorsum, and when seen from the side and in front with dark vittae; some slight whitish dust round prothoracic spiracle; margin of the scutellum more brownish than disk and slightly shining. Abdomen brown, first to third visible tergites with white, almost silvery, dusting which is not very dense, and is most conspicuous when viewed from in front. Legs dark brown, the tarsi except their apices testaceous. Wings yellowish hyaline, black at extreme bases and on costal vein at apex of auxiliary vein. Halteres yellow.

Frons subquadrate, anterior orbitals hardly more than half as long as posterior pair, ocellars very short and fine, postverticals short; third antennal segment fully twice as long as wide, slightly narrowed at apex; arista plumose; face with a slight but distinct hump on each side below; palpi broad. Thorax with two pairs of strong postsutural dorsocentrals, one pair of prescutellar acrostichals, about 12 series of intradorsocentral hairs, one sternopleural, the prosternal plate broad and with microscopic hairs, the scutellum convex, rounded in outline, and with four bristles, the basal pair incurved, the apical pair divergent. Abdomen stout, apices of tergites 2 and 3 bristled. Legs normal, no anteroventral comb on fore femur. Inner cross vein at about three-sevenths from base of discal cell, penultimate section of fourth vein subequal to ultimate, the latter slightly forwardly sloped apically.

Length, 6 mm.

One male, near Para, Brazil (Miss H. B. Merrill).

Type.—Cat. No. 40711, U.S.N.M.

This species is readily distinguished from any black one by the white-dusted abdomen and its large size. It belongs to the segregate containing the genotype, in which there are two slight but evident humps on lower portion of the face.

MINETTIA INFUSCATA, new species

Female.—Head black, subopaque, slightly shining on frontal orbits, with pale gray dusting, most dense on face; antennae fuscous, base of third segment yellowish below; palpi fuscous. Thorax black, shining, the dorsum evenly and slightly gray dusted, and without vittae, pleura more densely gray dusted. Abdomen shining black, hardly dusted. Legs testaceous yellow, whitish dusted, femora

almost entirely blackened; apices of tarsi dark. Wings almost uniformly fuscous, paler along costa at base, and slightly hyaline along hind border basally. Halteres yellow.

Frons a little longer than wide, all the bristles except the ocellar pair long and strong; antennae normal; arista with its longest hairs not as long as width of third antennal segment; face almost flat; eyes tapered below, cheek very narrow. Thorax with two pairs of long strong dorsocentral bristles, in front of anterior pair a pair of short setulae, one pair of strong, prescutellar acrostichals, and about 12 series of intradorsocentral hairs; intra-alar short; only one sternopleural present. Fore femur without an anteroventral comb. Inner cross vein close to middle of discal cell.

Length, 4.5 mm.

One female, Cabima, Panama, May 29, 1911 (A. Busck).

Type.—Cat. No. 40957, U.S.N.M.

MINETTIA TUCUMANENSIS, new species

Male.—Shining pale brownish yellow. Frons except the orbits dull; antennae and palpi pale. Thoracic dorsum not vittate; scutellum with a deep black spot at base of each apical bristle. Abdomen with a black central streak on each of the apical three or four tergites. Wings clear, with the following dark brown marks: A broad costal streak from base round apex, extending to middle of submarginal cell, connecting with the dark marks on apices of veins 3 and 4 and fused with the spot over inner cross vein and the two spots on apical section of third vein, a conspicuous cloud over outer cross vein, and a fainter one on base of third vein. Halteres brownish yellow.

Frons a little longer than wide, parallel-sided, orbital and vertical bristles long and strong, ocellar pair very short and fine; face almost flat; arista pubescent; some of the bristles on lower portion of occiput quite well developed. Thorax with three pairs of strong postsutural dorsocentrals, one pair of strong prescutellar acrostichals, the intra-alar not very strong, and about 10 series of intradorsocentral hairs; both sternopleurals strong; prosternum haired. Abdomen ovate. Fore femur without a definite anteroventral comb; mid tibia without posterior setulae. Inner cross vein a little beyond middle of discal cell.

Length, 5 mm.

One male, collected at light between Tucuman and Jujuy, Argentina, on May 4, 1927, by Max Kislink, jr.

Type.—Male; Cat. No. 40956, U.S.M.C.

MINETTIA QUADRATA, new species

Female.—Shining testaceous yellow. Ocellar spot slightly darkened; antennae and palpi yellow. Thorax not vittate. Abdomen

with a dark central streak in middle of apical three tergites. Wings clear, with seven large dark brown marks as follows: An angulated streak from stigma extending over inner cross vein, a subquadrate spot on middle of fifth vein, a subquadrate mark on costa between apices of first and second veins, which is carried over third vein at less than one-half its width on costa, a similarly shaped spot at apex of second vein, a spot on apex of third vein which connects along costa with one on apex of fourth, and a large spot enclosing outer cross vein. Legs and halteres yellow.

Frons subquadrate, all bristles except the ocellar pair long and strong; arista rather distinctly pubescent; eyes rather abruptly narrowed below; cheeks narrow. Thorax with three pairs of strong dorsocentral bristles, the anterior pair close to suture, a pair of long prescutellar acrostichals, six series of intradorsocentral hairs, and the intra-alar bristles very short; sternopleura with one bristle. Fore femur without an anteroventral comb, inner cross vein about two-fifths from middle of discal cell.

Length, 3.5 mm.

One female, Cayuga, Guatemala, April, 1915 (W. Schaus).

Type.—Cat. No. 40958, U.S.M.C.

The black costal setulae extend rather near to apex of third vein but do not attain it.

MINETTIA BRUNNEICOSTA, new species

Male and female.—Shining brown; the head more clay yellow, with frontal orbits and face gray dusted; thorax gray dusted, when seen from behind with four darker vittae anteriorly, the outer vittae on lines of dorsocentrals, the regions laterad of these darker; abdomen almost without dusting. Legs brownish testaceous. Wings dark brown on costal half, the dark color fading out posteriorly, and disappearing behind fourth vein. Halteres brownish yellow.

Frons nearly twice as long as wide, parallel-sided, all bristles except the ocellar pair long and strong; arista long and slender, finely pubescent; eyes narrowed below; cheek about as high as width of third antennal segment. Thorax with three pairs of postsutural dorsocentral bristles, one pair of presutural acrostichals, eight series of intradorsocentral hairs, and the intra-alar quite strong; both sternopleurals present. Fore femur without an anteroventral comb. Inner cross vein beyond middle of discal cell.

Length, 3.5–4 mm.

Female and allotype, Cano Saddle, Gatun Lake, Panama, May 13, 1923 (R. C. Shannon); paratype male, Cacao Trece Aguas, Alta vera Paz, Guatemala, April 21 (Barber and Schwarz).

Type.—Cat. No. 40959, U.S.N.M.

MINETTIA VERTICALIS, new species

Female.—General color and habitus similar to the last preceding species, but the femora and tibiae are darker than the tarsi, the frons is only about 1.5 as long as wide, the antennae are comparatively smaller, the face more noticeably convex below, and the arista is bare. A striking feature of the species is the large number of rather strong, moderately long, bristles across the vertex. The outer cross vein of wing is slightly oblique.

Length, 5 mm.

One female, Cayenne, French Guiana (W. Schaus).

Type.—Cat. No. 40960, U.S.N.M.

SAPROMYZA SCHWARZI, new species

Female.—Testaceous yellow, shining. Frons with a broad brown central vitta which is fully one-third of the width of frons and is bifid in front; antennae brownish fuscous, third segment yellow at base; face with a brown spot in centre of lower margin; palpi fuscous. Thoracic dorsum with four conspicuous dark brown vittae, the submedian pair the narrower and continued to beyond middle of scutellum; an oblique vitta of same color on mesopleura and a large spot on upper part of sternopleura. Abdomen in both specimens before me shriveled so that it is impossible to give details of markings, but there are evidences of dark-brown markings on the tergites. Wings clear. Legs testaceous, fuscous on apices of fore and hind femora, most of mid femora, all of fore tibiae and tarsi, and apices of mid and hind tibiae. Halteres yellow.

Frons subquadrate, of almost uniform texture, shining, and without fine hairs, anterior orbital farther from eye than posterior and much shorter than it, ocellars rather short, about equal to postverticals; arista with its longest hairs fully as long as width of third antennal segment. Thorax with two pairs of postsutural dorsocentrals, a pair of prescutellar acrostichals in line with posterior dorsocentrals, four series of intradorsocentral hairs, situated on the sides of the two submedian dark vittae, and only one sternopleural; scutellum convex. Legs normal, no anteroventral comb on fore femur. Inner cross vein a little beyond middle of discal cell, apical section of fourth vein about three times as long as preapical.

Legnth, 3 mm.

Two females, Cacao, Trece Aguas, Alta Vera Paz, Guatemala (Barber and Schwarz); paratype, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Cat. No. 40961, U.S.N.M.

This species is dedicated to Dr. E. A. Schwarz.

Genus GRIPHONEURA Schiner

Griphoneura SCHINER, Novara Exped., 1868, p. 281.—MALLOCH, Proc. Biol. Soc. Wash., vol. 38, p. 75, 1925.

My paper on this genus, which appeared in May, 1925, antedates the part of Doctor Hendel's paper in which he deals with it.

GRIPHONEURA SUFFUSA Malloch

There appears to be no doubt that *proxima* Hendel is the same as this species.

GRIPHONEURA TRIANGULATA Hendel

This species is distinct from any known to me in having the apex of wing clouded and the cross veins with isolated clouds, the palpi black, and several other characters not found in the other spcies. I have not seen it.

Described from Peru.

GRIPHONEURA FERRUGINEA Schiner

Griphoneura ferruginea SCHINER, Novara Exped., 1868, p. 281.

When I wrote my revision of the genus I had not seen this species, which is the genotype. It is strikingly different from the other species in color, being brownish or yellowish testaceous, with the thoracic dorsum darkest, especially laterally at the suture, and the wings are yellowish hyaline, without dark apices.

The fore tarsus in the male has the same flattened area on base of first segment as have the other species, and here it is over half the length of the segment. There are two conspicuous bristly hairs at apex of fore tibia above which extend to middle of first tarsal segment. The first posterior cell is practically closed at the apex and the bend of fourth ven is evenly rounded.

Length, 4 mm.

Locality, Higuito, San Mateo, Costa Rica (P. Schild). Two specimens in the United States National Museum.

I have compared the above two specimens with the type specimen of *ferruginea* Schiner, sent me for examination by Doctor Zerny of the Austrian National Museum, and find they agree in all particulars with it.

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A NEW PTEROSAURIAN REPTILE FROM THE MARINE CRETACEOUS OF OREGON

By Charles W. Gilmore
Curator of Vertebrate Paleontology, United States National Museum

Through the kindness of Prof. E. L. Packard, of the University of Oregon, I have recently received for study a fossil specimen found by him in the marine Cretaceous rocks of eastern Oregon. This specimen clearly belongs to the Pterosauria, and, as this reptilian group has not previously been known to occur in the Pacific coast region of North America, the discovery is of much scientific interest.

In North America pterosaurian remains have been found in the marine Niobrara Chalk of western Kansas and in the fresh-water Morrison deposits of Wyoming. Three genera are recognized—*Pteranodon* and *Nyctodactylus* from the Niobrara, and *Dermodactylus* from the Morrison formation. The first two mentioned genera are adequately defined from well-preserved specimens; but the latter, founded on a single incomplete and poorly preserved skeleton, is at this time inadequately characterized.

Well-preserved pterosaurian specimens are among the rarest of American reptilian fossils, and when this pterosaurian fauna is contrasted with those of Great Britain and Europe, with their great number of genera and species of wide geological range, the paucity of our rocks in pteryodactyle remains becomes strikingly apparent. This comparison serves also to accentuate the importance of this latest discovery, in greatly extending their known geographical range as well as furnishing a representative of the order that is intermediate in geological position between the earliest and latest known American members.

In regard to the geological occurrence of this specimen, Professor Packard, under date of September 19, 1927, writes me as follows: "These specimens were found in Cretaceous shales associated with a determinable ammonite fauna of Lower Chico, or possibly Upper Horsetown age." The specimens referred to in the above citation are the pterosaur and an ichthyosaur,[1] the first and only vertebrate remains so far found in this formation.

[1] Merriam, J. C., and Gilmore, C. W., Carnegie Instit. of Washington. Pub. No. 393, 1928, pp. 1–4.

The unique geographical occurrence of this Oregon fossil in conjunction with its intermediate geological position appears to justify its description as a new species, and the specific name *oregonensis* is proposed for its reception. As a matter of expediency awaiting the discovery of more diagnostic materials, this species is tentatively assigned to the genus *Pteranodon*. That it may pertain to a new genus is a fact fully recognized but one that can only be determined by the discovery of more complete specimens.

PTERANODON (?) OREGONENSIS, new species

Type.—Consists of a nearly complete left humerus, two coossified dorsal vertebrae and the articular end of an undetermined bone. Collected by E. L. Packard, 1927.

Type locality.—"Mitchell Quadrangle, Wheeler County, Oreg., S. E. 1/4 sec. 36, T. 26 S., R. 21 E. About 200 feet above gorge of a small east gulley leading into Nelson Creek about 1/4 mile above its mouth, not more than 200 feet from southward bend in Nelson Creek Road after it reaches the flat."

Geological occurrence.—Upper Chico, or Lower Horsetown, Cretaceous.

Description.—The few bones preserved of this specimen are remarkable on account of their uncrushed preservation, an unusual condition in flying reptiles. On account of the fragile hollow structure of the bones of the pterosaurs, and especially those from the Niobrara Chalk, they are usually much flattened, with their natural configuration so altered as to leave one in doubt as to their original form. Fortunately, these bones have not suffered in this respect, although important parts of certain of the processes have been lost either through erosional agencies before the specimen was discovered or have been destroyed by subsequent attempts at preparation.

When the humerus came into my hands it was in two pieces, and although the two broken surfaces appear to show contact at the middle of the shaft and the external contours seem to be in accord on all sides, a slight doubt exists as to their being properly united. Professor Packard, however, assures me that there can be no doubt of their belonging together.

A critical comparison of the humerus with the humeri of other American pterosaurs is rendered quite unsatisfactory due to the crushed and flattened condition of all of the Niobrara fossils. Eaton [2] has called attention to this flattening as follows:

> The vagaries of form assumed by the humerus [in *Pteranodon*] under pressure in the matrix are very surprising, the first result of this perplexing situation being that almost every humerus in the collection seems to represent a

[2] Eaton, G. F., Memoirs Conn. Acad. Arts and Sci., vol. 2, 1910, pp. 28–29.

distinct species. From an examination of 14 practically complete humeri of *Pteranodon* variously distorted, it appears that pressure in the vertical direction (the vertebral axis of the pteryodactyl being supposed to lie in the horizontal plane, with the wings outstretched latterly) usually crushes and shortens the radial crest, while pressure in the horizontal plane not only leaves the radial crest extended to its full length but also alters the head of the humerus in such a way that the radial crest appears to originate farther from the proximal condyle.

It is therefore quite obvious that comparisons made with this material can not be relied upon. Fortunately, a few fragmentary humeri from the Cretaceous deposits of England have retained their natural configurations, and they offer a better basis of comparison with the Oregon humerus.

The humerus is gently sigmoid from end to end. The ends are widely expanded, the distal exceeding the proximal in its transverse diameter, and planes projected through the longer axes of these ends would bisect one another at nearly right angles. The head is elongate, roughly crescent shaped in outline, with the longer axis transverse. The articular face is convex anteroposteriorly and slightly concave or saddle-shaped transversely. Much of the deltoid crest is missing in this specimen, but its great development is clearly apparent.

This process springs from the outer border at some distance below the head, as clearly shown in Figure 1. Its broken base has a greatest longitudinal diameter of 35 millimeters. The ulnar crest is strongly developed, and it springs from the inner border, nearer but also below the level of the proximal end. Comparison with flattened *Pteranodon* humeri seems to indicate a more robust development of this process in the Oregon specimen, and its extension downward on the side of the shaft appears to be greater. These differences, however, may be more apparent than real, for there is so much variation in the Niobrara humeri that little reliance can be placed in observed characters. Between the deltoid and ulnar crests the ventral surface of the humerus is strongly concave but becomes convex immediately below the lower border of the deltoid crest. The shaft decreases in size until in the middle it has a least diameter of 17.5 millimeters; distally it gradually but rapidly expands to the distal extremity. The distal end has suffered the loss of its outer articular surface, and abrasion of the inner surfaces renders their exact interpretation uncertain. There is a large depression in the center of this end, but it is not at all comparable to the deep circular foramen found in the humerus of *Ornithodesmus*, as described by Hooley.[3]

[3] Quart. Jour. Geol. Soc. London, vol. 69, 1913, p. 386, pl. 39, fig. 3.

Measurements of humerus

	Millimeters
Greatest length	183.0
Greatest width of proximal end	42.0
Greatest width of distal end	57.5
Least diameter of shaft	17.5
Anteroposterior diameter of head	20.5
Anteroposterior diameter of distal end	28.0

Vertebrae.—The vertebral column is represented by two vertebrae that are fully coossified. These are uncrushed, and except for the loss of the tops of the neural spines and ends of the transverse

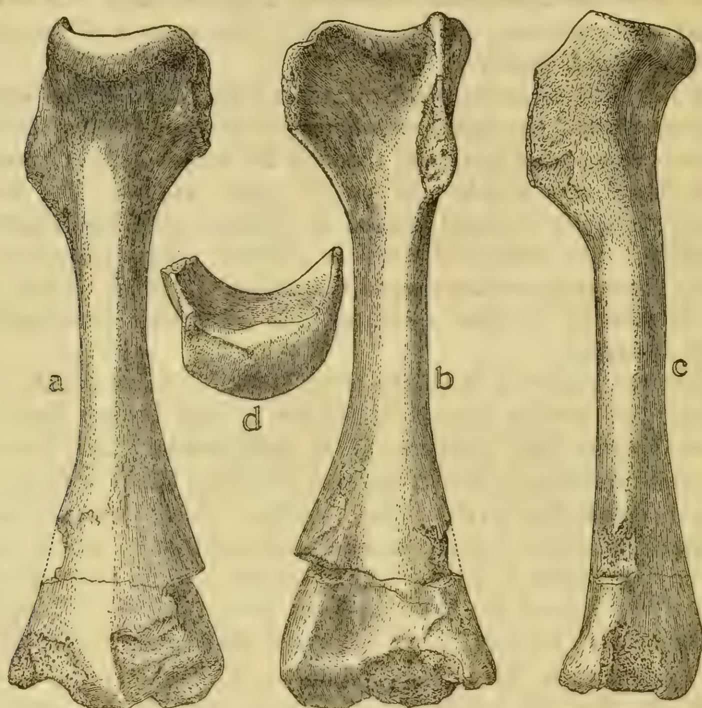

FIG. 1.—LEFT HUMERUS OF PTERANODON (?) OREGONENSIS. TYPE. *a*, POSTERIOR VIEW; *b*, ANTERIOR VIEW; *c*, EXTERNAL VIEW; *d*, PROXIMAL VIEW. ALL FIGURES ONE-HALF NATURAL SIZE

processes are in an excellent state of preservation. Comparisons made with the vertebral column of *Pteranodon* seems to indicate their position to be in the posterior dorsal region. The position of the transverse processes, which have their origin above the level of the neural canal, centra constricted at the middle with expanded ends, and steep inclination of the zygapophysial facets are all features indicative of their posterior thoracic position as shown in Figure 2. In *Pteranodon* the dorsal series consists of eight anterior coossified vertebrae, which is designated the notarium, and they are followed by either three or four free vertebrae which fill the interval between the notarium and the coossified series forming the sacrum.

From a review of all available evidence it is my conclusion that the two vertebrae now before me belong to this free series. The fact of their being coossified does not necessarily argue against this conclusion, for in living birds aged individuals often show ossification of ligaments as well as the coossification of the spinous, transverse, and zygapophysial processes of the vertebrae, and it does not seem unreasonable to believe that a somewhat similar condition might take place in the backbone of these extinct flying reptiles.

When compared with the free vertebrae of *Pteranodon* the greatest dissimilarity noted is in the more prominent development of the ball

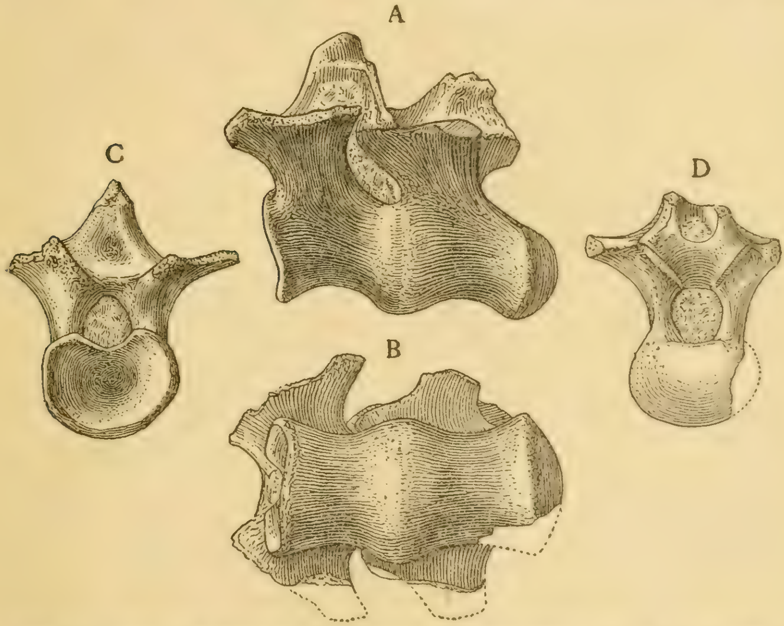

FIG. 2.—DORSAL VERTEBRAE OF PTERANODON (?) OREGONENSIS. TYPE. *a*, LATERAL VIEW FROM THE LEFT SIDE; *b*, VENTRAL VIEW; *c*, ANTERIOR VIEW; *d*, POSTERIOR VIEW. ALL FIGURES NATURAL SIZE

in the Oregon specimen, which gives the centrum a correspondingly increased length. The pedicels of the arches are also relatively wider anteroposteriorly. The transversely oval shape of the cup, the large size of the neural canal, the steep inclination of the zygapophysial facets are all features in close accord with the dorsals of *Pteranodon*.

Measurements of coossified vertebrae

	Millimeters
Greatest length of coossified centra	40
Greatest transverse diameter of anterior centrum	18.5
Greatest vertical diameter of anterior centrum	15.0
Greatest vertical diameter of posterior centrum	14.0
Width across anterior zygapophyses	18.5

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